

THE LIFE OF
LORD MOULTON

H. FLETCHER MOULTON



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THE LIFE OF LORD MOULTON



LORD JUSTICE FLETCHER MOULTON.

From a pastel painting by Trevor Haddon, R.B.A.

THE LIFE OF LORD MOULTON

BY
H. FLETCHER MOULTON

WITH A PREFACE BY
THE EARL OF BIRKENHEAD



London
NISBET & CO. LTD.
22 BERNERS STREET, W.1

First published in 1922

*Printed in Great Britain by Hazell, Watson & Viney, Ltd.,
London and Aylesbury.*

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TO

MY WIFE

MY FATHER'S CONSTANT COMPANION AND HELPMATE

THROUGHOUT THE STRAIN OF THE WAR

THIS BOOK IS

AFFECTIONATELY DEDICATED

PREFACE

IT is with very great pleasure that I write a few words of introduction to the life of my old friend—Lord Moulton.

He was, in truth, a very remarkable man. I was never myself brought into contact with a mind which impressed me more by its brilliancy, scope, and power. In many ways he was the quickest and ablest Judge before whom I ever practised at the Bar. Indeed, only one criticism could possibly be made of his judicial quality. The mind was so powerful, and so self-confident, that it did not always offer sufficient scope to the persuasiveness of argument. The formidableness of the man—alike as Advocate and as Judge—was extraordinary. Indeed, he worked far more rapidly in a case of which an hour ago he had known nothing, than brilliant advocates who had studied it for days.

And it must not be forgotten that this very remarkable man was also a well-equipped scientist. I need not recall here the brilliancy of his forensic career as exhibited in technical and remote branches of the Law : it is true to say that no man since the great Bacon has brought to the Bench so consummate a scientific equipment.

The services of Lord Moulton during the war are fully set out in the pages that follow, and it is indeed an amazing story. A Judge learned in the Law, at the outbreak of the greatest war in history, is transplanted from the Bench to the Ministry of Munitions in order to enrich, by his scientific ingenuity, the destructive processes of modern war. And it is universally admitted that, on the scientific side, his individual contribution to winning the war was as great as that of any contemporary Englishman.

And here, as he would have wished, we may be content to leave it. He was a man who neither invited nor particularly cared for compliments or applause. The profession to which he belonged, and the Bench which he adorned, will long recall his brilliant intellect with esteem and admiration.

BIRKENHEAD.

November 5th, 1922.

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THE LIFE OF LORD MOULTON

CHAPTER I

BOYHOOD AND CAMBRIDGE

MY FATHER was born on November 18th, 1845, at Madeley in Shropshire. His father, the Rev. James Egan Moulton, was the Wesleyan minister in charge of the circuit, and not unnaturally named his son after that Vicar of Madeley, John Fletcher, who had been John Wesley's right-hand man and, indeed, designated as his successor.

The Moultons were a family of no locality. Lord Moulton's father, grandfather, and great-grandfather had all been Wesleyan ministers and subject to the rule of the three-yearly change of circuit, and so were almost equally identified with every part of England. Before John Fletcher Moulton left home he had lived in Madeley, Bolton, Preston, Tipton, Plymouth, Northampton, Tynemouth, and the Channel Islands.

The family was a large one, there being four boys, William, Egan, John, and Richard, and two girls, Annie and Lizzie, John being the fifth child. They all proved to be remarkably long-lived, only one (William) failing to reach the age of seventy. Their

mother died soon after the birth of the youngest son, Richard, and in 1857 their father married a Guernsey lady, Miss Taylor, who had been brought up in France. From her John acquired his excellent knowledge of French, which he further practised by marketing for the family in Guernsey. Family tradition says that he displayed great capabilities in beating down the local market women. If this be true, the boy was certainly not the father of the man, as in later years there was nothing he disliked more than bargaining on his own account.

The boys were all educated by their father, who had for seven years been head master of Kingswood School, Bath, where the sons of Wesleyan ministers were educated, and was both a profound scholar and a splendid teacher. At the age of eleven John Fletcher went to Kingswood, and was so far advanced that he at once went into the head master's class.

The education given at Kingswood was exceedingly good, but was of course chiefly concerned with the ancient tongues, and whilst there my father acquired a good knowledge of Latin and Greek, and even commenced Hebrew. He had already progressed so far in mathematics that the head master made him study the subject chiefly from French and German books, so that he might acquire at the same time a knowledge of modern languages.

By the time he was thirteen and a half, Moulton was head of the school. Normally boys only remained there till fifteen, but it was the custom of

the Wesleyan Conference to grant the head boy another year's education, and accordingly he was allowed to remain on till sixteen. Just at the end of his time there was held the first of the Oxford and Cambridge Local Examinations, and Moulton of Kingswood School came out head of all England in the total number of marks. His papers attracted such attention that one of the examiners wrote to his father and asked that the boy should be sent to Oxford, adding that financial difficulties should not be allowed to prevent this, as the College would certainly find a way of overcoming these in the case of such a brilliant scholar.

This examination was a great triumph for Kingswood School, so many of its boys attaining high places that the head master received letters from schools all over the country containing inquiries as to the books he used, and the methods of instruction he employed, in order to obtain such remarkable results.

School life then was still hard, and the holidays scarce. There was one term in the year—forty-six weeks long—and my father has told me how he felt quite joyful when there were “only twenty weeks more to the holidays.” All the same his recollections of school life were happy ones, and he always retained a great affection for Kingswood and to the end of his life kept in close touch with it.

The few reminiscences of his school life show that he was a thoroughly normal boy. He was always hungry, and when, as a prefect, he obtained the

magnificent allowance of a penny a week, it was regularly spent on the renowned Bath Chaps. One of his most severe trials was the very long sermon which marked each Sunday service, and during which he regularly fell asleep. As this was apt to lead to painful consequences, he acquired the power of sleeping without closing his eyes. A recent speech by one of his contemporaries, the Rev. Mr. Davison, discloses how the speaker ventured to interrupt one of Moulton's open-eyed slumbers, with the result that these two dignitaries-to-be celebrated the end of the service by a fight, whose issue is not recorded.

One of his important functions in the school life was very reminiscent of David Copperfield—he was the official story-teller to his dormitory, and was expected nightly to provide a satisfactory ration of adventure. Unfortunately such stories do not survive, but I remember one typical incident which shows how he could bring a sound mechanical knowledge to the assistance of his fictional abilities. One night his improvisation had brought his hero into a really tight place—mounted on a tired horse he was closely pursued by a band of Indians, whilst before him yawned a crevasse, which the author had somewhat rashly pronounced unjumpable. An announcement that the rest of the story would be told the next night brought temporary relief to the situation, but clearly a big effort was necessary if the reputation of his stories was to be maintained. The day's respite brought the solution, and next night the hero

spurred his flagging horse into a wild jump at the crevasse, then as it began to sink six feet from the other side, drawing his feet up on to the saddle he sprang to safety on the bank, while the impetus sent his gallant steed crashing into the unfathomable depths below.

This suggests that had Lord Moulton's time not been otherwise occupied he might have made his name as a writer of adventure. In fact he always kept a taste for the better class of adventurous fiction.

One of his favourite reminiscences of Kingswood was a scene at the close of the school year when the head master according to custom accompanied his farewell to each boy by a word of praise or encouragement. There was one youth—let us call him Smith—whose career that year had been so unpromising that the other boys waited round to hear what the head master could possibly say to him—which in fact was, “Well, Smith, you’ve laid an excellent foundation for the improvement prize next term.”

On leaving Kingswood he obtained a post as assistant master at Dr. Conquest's school at Biggleswade. After a year and a half he went in a similar capacity to Dr. Rush's school at Northampton, in which town his father was then minister, where he remained for another two years. During this time he was reading steadily, and in 1861 he matriculated at London University, obtaining a scholarship of £30, and followed this up by obtaining a scholarship of

£40 at the first B.A. examination in 1863, and a further scholarship of £50 at the second B.A. examination in 1864.

In 1864 he suddenly decided to try for a scholarship at Cambridge, and, although he had done no reading for the special subjects of the examination, won the scholarship of £50 a year for three years at St. John's. After obtaining the scholarship he entered for the Little Go, in which he surprised the examiner by handing in his paper after only thirty-five minutes of the allotted three hours had passed. He was told that no candidate was allowed to go before the first hour was up, and the examiner begged him not to despair, but to try and see if there was not some question he could do. The reply was that all the questions had been answered, and the surprised examiner found that this was so.

Moulton's supremacy in the mathematical field was so early recognised at Cambridge that when, during his first year, he entered for the London University Scholarship, no one else thought it worth while to oppose him, and he and the examiners, Dr. Routh and Isaac Todhunter, solemnly travelled up to London by the same train. On arrival there the candidate and examiners were shown into the two large halls, each warmed by blazing fires, which had been reserved for the examination, and there the examiners sat in state, while the candidate completed the papers, watched by a full staff of invigilators to see that he did not cheat himself.

About the time that his son gained the scholarship at Cambridge, the Rev. James Moulton's health broke down so that he was no longer able to undertake circuit work. He therefore decided to live at Cambridge, and his son during his undergraduate career lived with his family in New Square. James Moulton had always been a man of great activity of mind, and when broken by illness he had a constant fear of being "left with nothing to do." His son came to the rescue by keeping him in touch with his own studies, both classical and mathematical, and giving him various mathematical manuscripts which he studied and discussed. Unfortunately he did not live to see his son graduate.

Of course athletics were far less important in those days, and so far as I can discover Lord Moulton took no part in them. He obtained his exercise by the traditional means of long, fast walks, and when occasion served by skating, of which he was very fond.

His undergraduate career comprised an unbroken series of triumphs in the May Examinations, varied by the capture of the Gold Medal for Mathematics at London University. In those days scholars were compelled to take both the Classical and Mathematical Mays, and he usually managed to obtain a first class in both, though he did no serious classical reading. On one occasion after an examination in which a Greek poem had been set for translation into English verse, one of the Classical scholars comparing notes with him as to their rendering of the passage said :

“ It’s very curious, Moulton, how you knew that word meant ‘ coy.’ I have read far more than you, and I have only met it once.” The answer was : “ I had never seen it, but I knew it had to rhyme with ‘ boy.’ ”

One of his contemporaries, Professor Reid of Christ’s College, describes Moulton in his undergraduate days as follows :

“ Moulton, as I remember him in our undergraduate days, was in one respect different from what he afterwards became. He was distinctly shy and rather difficult to approach, but a friend once made by him was never lost. I was struck by one conspicuous difference between him and other eminent mathematicians of the time. Classical men were apt (not without some justification) to regard them as narrow in their intellectual outlook, caring little or nothing about things beyond the mathematical horizon. Moulton’s literary interests were from the first keen and wide. He was an enthusiast for poetry, and carried much of it in his memory.”

Moulton coached with that most famous trainer of “ Seniors,” Dr. Routh. It was one of that coach’s peculiarities that he was never wholly satisfied with any work shown up to him. Moulton determined on one occasion that he would try to break the record by putting in answers to the weekly problem paper on which no criticism could be offered. When his work was returned he looked eagerly for Dr. Routh’s verdict, which was “ Fold neatly.”

As the time approached for the Tripos, Moulton

was looked on as more and more a certainty for the Senior Wranglership. In those days the excitement as to the result of the Mathematical Tripos was intense, and every precaution was taken to keep it secret until the official announcement. The list was written out overnight and the compositors who printed it were locked up all night, so that there should be no leakage. At nine in the morning the names of the Wranglers were read out to a crowded Senate House, after which the lists were thrown down to the waiting undergraduates, so that those who were not in the first class might find what place they had got.

Moulton had had to go to London the day before the result was announced, and had arranged with his sister that she should wire him if he were Senior. For some reason the result that year was not announced at the usual hour, and so no telegram arrived before he left London. To him there could be only one explanation—that the apparent certainty had broken down and he had been beaten. Thoroughly ashamed, he chose the most obscure ways to his step-mother's house, so that he might hear the exact result before meeting any of his friends. As he was creeping in by the back door he was seen by his favourite sister, who overwhelmed him with congratulations on the crowning triumph of his University career.

Not only was he Senior, but he had obtained the highest total of marks ever known. The difference

between his total and that of the Second Wrangler was greater than that between the marks obtained by the latter and those of the last of the Wranglers, who was forty-second on the list.¹ And it was a good year, over one hundred and twenty candidates entering, including Darwin, the son of the great naturalist and afterwards Professor of Mathematics and Fellow of the Royal Society, who was second, and Christie the late Astronomer Royal, who was fourth. Moulton followed this up by taking the first Smith's prize, then given on the result of a special examination, though now awarded for an essay on some mathematical subject.

Normally these successes would have certainly led to a Fellowship at his College, but at St. John's there were very few Fellowships open to laymen, so the Master advised him to take the Fellowship offered him by the sister foundation of Christ's College.²

At Christ's he was fortunate enough to obtain probably the most beautiful set of Fellow's rooms in the University. These had been designed by Inigo Jones himself as a model of what such rooms should be, but the design had been found too expensive to duplicate. In these rooms he entertained freely, his friends representing interests of all kinds. It was noticeable that at these gatherings the musical

¹ The marks were given (unofficially) as Moulton 7,700, Darwin 3,300.

² Both these Colleges were founded by Margaret of Lancaster (Lady Margaret), the mother of Henry VII.

element usually figured largely—often in the persons of Mr. (now Sir) Charles Villiers Stanford or the late Sedley Taylor. All through his life my father showed great interest in music and had a fine critical capacity, though he himself was utterly unable to play any instrument or to sing a note correctly—which was somewhat remarkable as his brothers had considerable musical talent. So noticeable was this that it was a stock family joke to get him to try to sing a common-metre hymn tune—in which he invariably got the intervals all wrong.

Among my father's contemporaries as Fellows of Christ's were Dr. Reid and Sir John Seely, Lord Wrenbury and Professor Reid. Sir Walter Besant and Professor Skeat had just vacated their Fellowships, though the latter still lectured there.

The College atmosphere was still redolent with reminiscences of Calverly. Among the stories my father told of him was that on one occasion the Master remonstrated with him for walking about the College Courts in a short jacket smoking a short black pipe, and said that such conduct must destroy the respect which undergraduates ought to feel for the Fellows. Calverly undertook that this should not occur again. The next day the Master noticed an unusual number of persons in the Court, and going to the window saw Calverly seated in a large arm-chair in the middle of the grass plot, attired in faultless evening dress and smoking a long churchwarden.

Among his more intimate friends at the University were Sir Charles Dilke and W. K. Clifford, and their companionship earned for him an early reputation for advanced Radicalism—judged by the standards of those days. This was probably accentuated by his breaking through one of the most honoured and least honourable of the old University traditions—that of the gulf between Town and Gown—by forming a reading circle which included not only Fellows, but some of the leading business men of Cambridge. The first paper he read at this Society—a review of evidence for Evolution derived from Embryology—was probably also somewhat of a trial to the more conservative minded.

He also seems to have set himself to train for the dialectics of a legal career by continually seeking arguments on subjects of which he knew little or nothing, provided that he could find someone who was an expert thereon for the other party to the argument. It was a saying of his, “Get your facts from your opponent and turn them against him.” For example, he created considerable amusement by reducing to blank silence a very High-Churchman over a fine point of ecclesiastical ritual of which he had known nothing whatever previously.

To Professor Reid I am also indebted for this sketch of my father in his days as a Fellow :

“After his great success in the Mathematical Tripos Moulton lost his shyness and became eminently

sociable, and a brilliant companion. I think that in his undergraduate time he was at first distrustful of his own powers, and that the Tripos gave him confidence in himself and a firm outlook for his future. He had a very wide circle of friends."

My father's lifelong friend, Lord Fitzmaurice, describes him as follows :

"The abiding impression produced by Moulton on all his contemporaries in our Cambridge days was that of his extraordinary versatility and general excellence in everything to which he put his hand. No doubt we knew some others who were good in more than one thing, and yet others who were good only in one thing ; and more who dabbled more or less successfully in all sorts of things. But to him all-round excellence seemed to come easily and naturally. This quality, combined with his immense power of work and physical vigour, gave him the same unquestioned position which he also acquired in after-life in so many and such varied fields of action."

After being elected to the Fellowship at Christ's College Moulton became a tutor there and also did much private tutorial work. Among his pupils were several of the earliest women students of Cambridge, in fact he lectured at the Women's College at Hitchin under the headship of Miss Emily Davies before that College was moved to Girton. Among these pupils was Miss Dove, afterwards head of Wycombe Abbey.

During his time at Cambridge he took a prominent

part in the Debates at the Union, of which he was elected President in 1868. Subsequently he held the post of Treasurer till he left Cambridge in 1873. The Treasurer's duties involved taking part in the private business debates when suggestions for improvements in the facilities offered by the Union to its members were discussed. One of the motions brought forward during his period of office was "That in view of the number of attendances required at Chapel, it is expedient that more novels be bound like prayer books." Another controversy at this time was as to the proposed opening of the Union on Sundays, which was bitterly opposed by the Sabbatarian party on the ground that it would involve Sunday labour, viz. the attendance of a doorkeeper, and also by the more practical officials on the opposite ground that Sunday was the day when everyone there was busy with the weekly cleaning. The final solution of the question was rather curious. A rule of the Union could only be altered by a two-thirds majority with at least forty voting. Although there was and had been for a long time a majority of the members in favour of Sunday opening, the Sabbatarian party were sufficiently strong to prevent the required two-thirds majority. The Treasurer, however, looked up the circumstances under which the Union had, forty years before, been closed on Sundays, and found that the resolution for closing had been carried by 25 to 12—only 37 voting. He therefore brought up a resolution to review the

Chairman's ruling at the old meeting, and to declare that the Union had never closed on Sundays, and as this did not propose any change in the rules a simple majority only was necessary, which was easily obtained.

The records of the Union debates in which he took part are interesting not only as showing his views, but also those of the average undergraduate in the sixties. Moulton was always on the progressive and almost always on the losing side, on motions for which an opponent could now hardly be found. One of his earliest speeches was in support of some extension of the franchise to women—a proposal which met with a crushing defeat, while other ideas which he favoured and which were too advanced for the undergraduates of the day were the abolition of religious tests in the University and the reform of the Cambridge Educational system. He also spoke in support of a motion regretting the refusal of the Oxford University to bestow an honorary degree on Robert Browning, the defeat of which by a majority of three to one was probably largely due to the spell which Tennyson had cast over the poetically minded. The one occasion on which he spoke on the winning side was in a debate in which he himself moved "That the state of Ireland justifies the use of extraordinary conciliatory measures." After an amendment proposing separation had been negatived this was carried by 115 to 57—a surprising contrast to the fate of the other Liberal proposals mentioned above.

His term as President was marked by one unusual incident—the moving of a formal vote of censure on the President for having issued a notice without due executive authority. I do not know the exact result of the debate—which seems to have been rather in the nature of a “rag”—but apparently the motion was unsuccessful, as my father finished his term of office undisturbed.

One distinction of which my father was always very proud was his election to the “Apostles”—that untalked-of band which ever includes twelve of the most brilliant members of the two Universities. His election as a Johnian was a special honour, as at that time the Cambridge members were nearly all Trinity men.

In 1871 Lord Moulton commenced to read for the Bar, and in 1873 he decided to leave the University and come to London.

Shortly after he married, and according to traditional custom sent to the Fellows of his College a section of the wedding cake wrapped in his formal resignation of his Fellowship. Apropos of the vacation of Fellowships on marriage, then the universal rule, my father used to tell a story of how the Fellows of a college (I think it was St. John's) received news of the death of one of their number who had been resident in South Africa for a quarter of a century, and shortly after an appeal from a lady there begging that they would continue to pay her the Fellowship, “which has been my husband's sole

means of support throughout our long and happy married life."

A few words may be said here as to his family, which was very intimately connected with the Wesleyan movement. His great-great-grandfather, George Bakewell, was one of John Wesley's intimate friends. His great-grandfather, Dr. James Egan, who married George Bakewell's daughter, was a gold medallist of Dublin University; and his grandfather, the Rev. William Moulton, and father, the Rev. James Egan Moulton, were both distinguished scholars, though the ban on Nonconformists prevented them from taking University degrees.

His eldest brother, Dr. William Moulton, was a brilliant all-round scholar. Although in later years he was best known as a Greek scholar, he also carried off the Gold Medal for Mathematics at London University four years before his younger brother. He also distinguished himself by taking all four branches of the Divinity examination instead of the usual two, and coming out head in each. He too was barred from Oxford and Cambridge, and after taking his M.A. at London University he became teacher at the Richmond College, where candidates were prepared for the ministry. Here he completed his English edition of Wieners' grammar of the Greek language as used in the Septuagint and New Testament, an edition which is still the standard work on these subjects. This led to his being appointed to the Committee which prepared the Revised Version of the Bible.

In 1874 he was appointed first head master of the Leys School at Cambridge, where he continued till his death in 1898. His success there is too well known to need comment, and in a very short time the school took a worthy place among the great public schools, not only in scholarship, but also in sports.

Shortly before his death he completed in conjunction with Rev. A. S. Geden, of Oxford, a monumental concordance of the Greek texts of the New Testament. Besides being an M.A. of London he was a Doctor of Divinity of Edinburgh, and an honorary M.A. of Cambridge University. Had he lived a few weeks longer he would have been still more intimately connected with this University, as it had been practically decided to elect him to the one Professorship of Divinity there which can be held by a layman—an unprecedented step in the case of a Nonconformist. Dr. Moulton was elected President of the Wesleyan Conference for the year 1890.

His son Dr. James Egan Moulton was a worthy successor to his father as a classical scholar, and was for very many years head of Didsbury College. Later he studied and wrote largely on the Parsee and Zoroastrian religions and their relation to Christianity, and made several missionary tours to India. His brilliant career was cut short in 1916. When returning from one of his Indian tours, his ship was torpedoed by a German submarine, and though after

four days he reached land in a small boat, he died of cold and exposure. Ten days before his eldest son had been killed on the Somme.

Dr. Moulton's other son, the Rev. William Fiddian Moulton, has for many years been one of the teaching and examining ministers dealing with candidates for the Wesleyan ministries, and is also the author of several books.

The second of Lord Moulton's brothers, the Rev. Egan Moulton, went as a missionary to Tonga and translated the Bible into the Tongan language, largely from the original Greek. He was also the head of Newington College, Sydney, and was President of the Wesleyan Conference in 1893.

His younger brother, Dr. Richard Moulton, was a scholar of Christ's College, Cambridge, and has devoted himself to the study of literature, more especially the literature of the Bible and Shakespeare, and also that of the Greek dramatists. Among the best known of his works are *The Literary Study of the Bible*, *Shakespeare as a Dramatic Artist*, and *The Moral System of Shakespeare*, while he was also an editor of *The Modern Reader's Bible*.

For twenty years he devoted himself to University Extension Lectures, but in 1892 he was offered and accepted the Chair of English Literature at Chicago University, which he occupied till 1916.

CHAPTER II

AT THE BAR

MR. FLETCHER MOULTON was called to the Bar in the Michaelmas term 1874, and read in the chambers of Mr. W. G. Harrison at 11, King's Bench Walk. After his year as a pupil had expired he continued in these chambers, and in fact occupied them till his elevation to the Bench in 1906.

Mr. W. G. Harrison (generally known as "Devil" Harrison) had one of the largest junior Common Law practices of the day. The period was a very interesting one from the practitioner's point of view, since it was just at the transition from the old to the new practice. From 1873 to 1884 a series of Judicature Acts were passed which changed and simplified the old procedure, but at the time when Mr. Fletcher Moulton came to the Bar many now extinct forms still remained. For example, if a defendant desired to "plead two pleas," i.e. rely upon alternative lines of defence, leave had to be obtained from the court on the application of counsel, and there were numerous other occasions for the display of a junior counsel's ability which have now been swept away.

These applications gave the beginner great opportunities, since a busy junior could not attend to them all himself and many were "devilled" by other barristers in his chambers. Making the most of these opportunities, Mr. Fletcher Moulton soon acquired a considerable clientele of his own and became one of the busiest of the Common Law juniors.

At this time also the distinction between the Common Law and Chancery jurisdictions was largely swept away. It was no longer necessary to go to the Chancery Courts for an injunction, while the merits of the action had afterwards to be tried out before a judge and jury in the Common Law courts, for now each court was given full powers over the cases brought before it. Prior to this time there had been a sharp distinction between counsel who practised on the Common Law and Chancery sides; this distinction now lost its sharpness, and Mr. Fletcher Moulton was one of the first juniors to practise freely in both courts, though in fact his practice was always chiefly in Common Law matters.¹

Mr. Fletcher Moulton's career at the Bar was so largely identified with Patent cases, and other cases depending chiefly on scientific matters, that it may come as a surprise that he had been many years at the Bar, and had built up a considerable practice

¹ Nevertheless the majority of his cases were tried before Chancery judges, since it has become a common practice to bring Patent and other Common Law actions where no jury is required on the Chancery side.

as a Common Law junior, before he appeared in any action of this nature. But in 1883 a new Act was passed which greatly cheapened and facilitated the grant of Patents for inventions, and which consequently largely increased the number of Patent actions, and it was soon realised that Mr. Fletcher Moulton's knowledge of science, and in particular his acquaintance with electrical matters which had earned him his F.R.S., were a great asset in these cases.

But his career as a Patent junior was short, for by 1885 his practice had increased to a point that justified him in applying for silk. From that time onwards there were few Patent cases of any importance in which he was not engaged.

If asked as to the distinguishing quality which most contributed to his success in these cases, I should say it was his extraordinary capacity for scientific thought, even in fields wholly new to him. As some men are born with a linguistic capacity which enables them after a short experience of a new language to grasp, apparently instinctively, not only its grammar but its genius and spirit, so he would come to some new branch of scientific work, and in the time of mastering what to most men would seem a few disconnected facts, gain a knowledge of the subject, and of the bearing and importance of these facts, that enabled him to discuss and appreciate the matter not merely as a lawyer, but also as an expert.

But this rapid power of mastery was to him a means, not an end. It facilitated, but did not excuse from, a further and thorough mastery of all details. In all important cases he insisted on long and full consultations where every possible aspect of the case might be considered and any possible objections met beforehand. It was his maxim that cases were more often won out of court by such preparation than by efforts at the trial itself. A phrase he often used with regard to these consultations was that they were for the purpose of "playing chess with oneself," and he encouraged every person present to suggest possible moves by the opponents so that their effect might be considered, and the proper answer found. *Vixere fortes ante Agamemnona*, but I think that to a large extent he was the originator of the modern idea that in scientific cases counsel should aim at such a knowledge of the matter that for the moment they meet the expert witness on equal terms.

But anyone acquainted with the life of a busy K.C. knows that emergencies arise where careful preparation is impossible, and on such occasions his scientific instinct stood him in good stead. I remember one of our most learned chemists telling me that on one occasion he met my father at his chambers to be told that he had not yet seen the papers in a complicated chemical case he was then due to open before the Comptroller-General of Patents. All instruction in the case was given in the course of the

half-mile walk to the Patent Office, when Mr. Fletcher Moulton in the course of an hour's speech explained the whole chemical problem with the greatest clearness.

But of course this power of acquisition and comprehension would be useless to a lawyer unless accompanied by the ability to convey the effect of this knowledge to others. This gift was his in a remarkable degree, and his aim was always to use it for the purpose of instructing the court in the true and scientific comprehension of the matter in hand. This task was not always an easy one. Many of the judges were wholly without scientific knowledge (the curriculum of our Public Schools in the middle of last century must be remembered), and, able as they might be in their own sphere, they often seemed to have neither the desire nor the capacity for appreciating scientific matters. In such cases the easy course would often have seemed to be to avoid delving deep for the truth, and to endeavour to win the case on superficial considerations having little bearing on the real merits. But such was not his way, and more often than not his efforts were justified by success.

In writing of Lord Moulton's legal career the biographer is faced by the difficulty that the great majority of the cases in which he was involved were not of a nature that appealed to the public interest, though they were of great commercial importance and the amount at stake was often very large. Those

who wrote of the careers of Sir Frank Lockwood or Sir Henry Hawkins could tell of their doings in cases which had been household words, and whose human interest had appealed to the public in general. But the atmosphere of my father's cases was entirely different, and the human element was almost non-existent in it. Nevertheless, his speeches were such models of scientific lucidity that they would furnish their own interest were it possible to give in a reasonable space a description of the points at issue and of his masterly treatment of them. Unfortunately this is not so, and I have not found it practicable to give in a few lines an exposition on, say, the importance and inner nature of the "di-alkylated Rhodamines" where he himself found that a two days' opening speech was necessary to outline the subject.

Amongst the more important patents with which he was concerned were the early patents for the telephone and the incandescent lamp, the Saccharin patents, the Dunlop Company's patents, and the Welsbach patents for gas mantles. These last two classes provided an immense amount of litigation, since the articles in question were easily made and could be sold broadcast. In particular the mantles were made by a host of small infringers, chiefly in little shops and houses in the East End, the only apparatus necessary being a basin and a gas jet. Of course Mr. Moulton was not in all these cases, as many were not important enough for the employment of a leader, but an idea of the volume of litiga-

tion may be got from the fact that a certain junior had on one day a hundred and fifty briefs to obtain judgment against infringers of the Welsbach patents.

I think Lord Moulton regarded as his greatest triumph a case which was neither remarkable for the length or complexity of the evidence, nor for the amount involved. This was the action of *Lyon v. Goddard*, and related to the patent for a machine for performing the process, now so well known, of disinfecting by steam. It had always been a problem how silks and other delicate fabrics dyed in colours which would not resist wet, could be disinfected without injury. Lyon suggested exposing them to the action of steam in a chamber which was surrounded by a casing which could also be filled with steam. The outer steam kept up the temperature of that actually in contact with the materials being cleaned, so that the latter always remained dry, i.e. none of the steam became water. For this to be so the steam must be kept at a high temperature and consequently at a high pressure.

The contest was as to the novelty of the invention, and the defendants relied chiefly on a previous machine which had been used in a laundry at Aberdeen, and which had outer and inner steam chambers of almost identical structure with those shown in the patent. The sole distinction that appeared was that the cover of the entrance to the steam chamber was secured by a somewhat flimsy catch.

Mr. Fletcher Moulton led for the plaintiffs in the

case, Mr. (now Lord) Finlay being the leading counsel for the defendants. The similarity between the plaintiffs' machine and the Aberdeen machine was so great at first sight that the judge—Mr. Justice Wright—twice recalled Mr. Moulton from other courts in which he was engaged to ask him if it was justifiable to waste the public time by keeping up so hopeless a struggle. These unpromising omens did not affect him, and in his reply he insisted that this apparently trivial variation in the locks of the machines constituted the whole difference between success and failure. With the flimsy Aberdeen lock you could not use steam at more than 4 lb. pressure, and at that pressure you could not get dry steam, consequently your materials were spoilt. By this argument Mr. Moulton not only turned the judge in his favour, but obtained unanimous judgments both in the Court of Appeal and the House of Lords, and procured from the Privy Council a five-years' prolongation of Lyon's Patent as being one for an invention of exceptional importance and originality. The whole case is one of great interest as showing how difference in substance and effect may make a small variation patentable.

Another story of interest is connected with one of Edison's early patents for the manufacture of carbon filaments for incandescent lamps. In this case the plaintiffs recognised that the most formidable issue was that of "utility," i.e. whether in fact filaments could successfully be made by the method described

in the specification. It was proposed to employ one of the most eminent scientific men of the day to demonstrate the practicability of the process. Mr. Moulton, however, advised an entirely different course. He saw that the difficulty was one of manipulation, and that such difficulty would soon be cured by practice. He recommended therefore that a dozen boys and girls just out of the elementary schools should be set to learn how to make these filaments. The suggestion was adopted, and a couple of months afterwards the expert witnesses for the defence were invited to a demonstration where they saw these boys and girls carrying out with ease the process which they themselves had considered impracticable. The proof was so overwhelming that the opponents themselves were convinced, and the utility of the patent was not further contested.

The relations between counsel and witnesses in this class of case is of a somewhat peculiar type. The main witnesses are generally scientific men of high standing who are called to bring before the court the various scientific facts which are necessary for the foundation of the legal arguments, and also to prove the results of experiments made to elucidate the points at issue. Frequently they are as well known to the court as the counsel themselves, and, apart from any other considerations, the care of their own reputation would prevent them from pledging themselves to facts which might be demonstrated to be untrue.

The position of the expert witness is one which has always puzzled laymen. It seems curious to them that an honourable man should be prepared to testify for either side according to his retainer. Argument as to law they can understand, but they feel that a fact is a fact and that there cannot be an opening for two views of it.

What they forget is that usually the court has not to find one way or the other as to the existence or non-existence of a simple fact, but to form the proper legal deduction from a number of facts presented to it. It is to these subsidiary facts that the witnesses testify; the deduction to be drawn from them is for the court and the court alone. Thus one of the most common issues in a patent case—is the variation from prior practice which forms the subject of the patent a new invention?—is an issue which the court cannot presume to decide till it is made fully acquainted with what was the prior knowledge and practice and what are the results which flow from the new departure. These are matters which are rightly the subject of evidence, but the issue for the court, viz. the existence or non-existence of invention, may not be made the subject of a direct question to a witness.

Various means might be devised to supply the court with the necessary knowledge, but the one which our law adopts is for each side to call witnesses who testify to those matters which are necessary for the foundation of their case, and then submit to

cross-examination by which the opposing counsel seek fuller explanation or qualification of the evidence already tendered, and further invite their comments on the facts to be proved by their own witnesses. There is very seldom a direct conflict of evidence, but the method ensures that all the circumstances which either side desires to bring to the notice of the court shall be presented under circumstances which allow the opponents the fullest power of criticism.

These cases therefore give rise to a series of duels between counsel and the opposing witnesses in which the opponents are on very equal terms, since the counsel are generally well acquainted with the scientific side of the matter, while the witnesses are perfectly familiar with the rules of procedure and the principles of law involved. Further, each party is from long experience well acquainted with the other's mentality. In these duels my father was at his very best, since his wide knowledge enabled him instantaneously to review the full effect of an answer and to test it by asking the witness to apply the principles he had enunciated to other facts chosen from his wide store of scientific experience, in a way which frequently led to a considerable modification of the effect of the original answer.

From a purely legal point of view this extension of knowledge of counsel and witnesses into each other's spheres had some inconvenience as they tended to get their rôles mixed. Indeed, a sarcastic judge remarked that in his court "Moulton generally

gave scientific evidence while the witnesses argued the law.”

It is hardly necessary to state that the personal relationship between my father and these scientific witnesses was of the most amicable nature, and many of those whom he cross-examined with the greatest severity were among his most intimate friends.

Omitting those now living I think that my father classed Sir Frederick Bramwell as his doughtiest opponent in the box. He had also a very great respect for him as an engineer, and he often quoted his sayings. One that particularly impressed him was Sir Frederick's opinion that throughout his engineering career he had only come across one really original mechanical device—that used by Plimpton to make a roller skate imitate the movements of the ice-skate in figure skating.¹

But though his cross-examination was severe it was always scrupulously fair, and he never took the view that a counsel has a free hand to attack the character of the opposing witness merely because his evidence is adverse to his client's case. On one occasion he was pressed by his client to ask an opposing witness—the case was about rose-growing, on which subject this gentleman had expert knowledge—whether he was not a convict released on licence from a sentence of penal servitude for life.

¹ My father used also to quote Lord Bramwell's version of the joke about witnesses, “There are liars, — liars, and scientific experts,—and then, of course, there's my brother Fred.”

Although my father knew this to be the case, he utterly refused to put the question, since in his opinion the witness had given his evidence fairly and truthfully and he would not be a party to raking up his past misdeeds for the mere purpose of attempting to diminish its effect.¹

One very important branch of Lord Moulton's legal work was that of advising clients as to the validity of their patents. The most usual, and most difficult, of the points that arise is that of subject matter, i.e. is the advance on prior knowledge made by the patentee sufficient to constitute what the Courts regard as invention? This question is one of fact rather than of law, since there is not, and cannot be, any verbal definition of what amounts to invention. It is very largely a matter of conjecture, since the counsel advising has to put himself in the position of the average judge, and decide how the question would probably appeal to his mind. The barrister who is most successful in effecting this mental impersonation is the one whose opinion is most trustworthy.

Case law in the usual sense—that is, seeking to find a particular decision that will cover the question—is almost useless here. But on the other hand a real appreciation of the general effect of past decisions is the most effective guide to the mind as to what the

¹ The witness (who is now dead) was in fact William Roupell, who was sentenced to penal servitude for life for forging his natural father's signature to a will which the latter had made but died without executing. He was obviously the subject of W. S. Gilbert's poem "Mister William" contained in the *Bab Ballads*.



[By permission.]

“PATENTS”

From the original cartoon by “Spy.”

courts will do in the future. Lord Moulton had this power of general appreciation in the highest degree, and relied on it greatly. He often said that he knew that his first impression on the validity of a patent was in all probability the right one. He might be argued out of it, or find that expressed in words it did not appear convincing, but if the matter went to trial, it would generally appear that his first view was the correct one.

Lord Moulton in this and in many other matters had a great belief in the unconscious or subconscious working of the trained mind, and its power of arriving at a decision without any mental use of verbal expression. This "back-of-the-brain" working is well recognised in its physical manifestations. Once skating has been learnt, the muscular efforts appropriate to maintaining the balance are made quite unconsciously, while the expert billiard player instinctively delivers a stroke of the right strength. Any conscious attempt at control would probably lead to disaster in both cases. Lord Moulton's view was that this extended also to the control of mental operations. He knew from early experience how the proper line of attack on a problem is revealed to the capable mathematician in a flash, but he considered that this apparently instantaneous result was the effect of continuous reasoning carried out in some portion of the brain whose action is far more rapid, and often far more skilled, than that part of whose operations the owner is conscious.

Second only in importance to his Patent practice were the cases involving questions of Trade Mark law. There is nothing more vital to the commercial community than the preservation to a trader of his most valuable asset—the reputation he has built up for the goods he makes or sells. For this purpose he generally chooses some name or mark which he places on them, and he is naturally most vigilant that none other shall use it. The courts had always recognised this right to some extent, but a plaintiff had, until comparatively recently, to prove on each occasion that the name or mark he sought to protect was generally recognised as indicating his goods, and, further, that the course adopted by the defendant would lead to actual deception of customers. This often involved long and expensive proof, and about the time that Lord Moulton was called to the Bar the Legislature began to permit the registration of certain marks as the property of particular traders, and the infringement of a mark so registered, providing that the registration could not be attacked, became actionable without any question as to the defendant's motives or proof of their probable consequences.

This right to registration was necessarily limited, since no trader could be permitted to acquire a monopoly in details of get-up which were common to the trade, or in words which others might legitimately desire to use to describe their goods. But undoubtedly the early limits were too strictly drawn, and there has since been a continual conflict between

the growing needs of traders for an adequate system of registration and the academic bounds put on the class of registrable words by the acts of the Legislature, and still more by the interpretation put on those acts by the older school of Chancery judges. Lord Moulton was able to obtain by his arguments a series of decisions which considerably relaxed these arbitrary restrictions on registration. In particular in the "Solio" case he established the right of a trader who has really invented a new word to register such word without his rights being defeated on the ground of some fancied meaning which could be attributed to the word.¹

The greatest weakness of the early Acts was that for registration purposes they wholly neglected (except in the very limited class of "old" marks, i.e. marks used before 1874) the effect of use as modifying the meaning of a word as employed in a particular

¹ The word "Solio" was registered by the Kodak Company for photographic papers. The chief objection to the word was that it might be held to contain some reference to "sol," the Latin word for the sun, and so be descriptive as applied to photographic papers. The lower Courts actually adopted this view, but the House of Lords reversed their judgment, holding that if a word was really a new one, it was an invented word, even though it might convey some indirect reference to the character of the goods. If a word were really new, its monopoly would not restrict other traders in the use of the ordinary vocabulary of the English language for the description of their goods, and so its registration would be outside the evil which the statutory restrictions sought to prevent.

In fact "Solio" was not chosen for any of these reasons. While a name was being sought, someone suggested "Soho," where the Company's works were situated. A carelessly written "h" was read as "li," and the euphony of the word "Solio" led to its adoption as the name of the famous paper.

trade. Whether a word was “distinctive” so as to be registrable, or “descriptive” and therefore not admissible for registration, depended wholly on its dictionary meaning, and was not, in the eye of the law, affected by the circumstance that it might in fact have been recognised for many years by the public as indicating the goods of a particular trader. Here Lord Moulton as counsel was unable to bring the law into line with common sense and actual fact; the improvement which he effected belongs to his history as a legislator.

Of course all these cases did not turn on such academic points, and Lord Moulton was counsel in actions relating to many of the most important trade marks and trade names in this country—cases where the motives of the defendants ranged from a *bonâ-fide* claim to the use of a name or get-up as really part of the property of the trade in general, to others where those motives were of the most fraudulent and barefaced description.

Lord Moulton had at one time a considerable practice at the Parliamentary Bar, particularly in regard to Bills relating to electrical undertakings such as tramways and telephones, but the great press of Patent work during the nineties left him little time for these cases. Of course he had to abandon this practice when he entered Parliament.

Another important branch of his work related to disputes as to building contracts—among which may be mentioned the disputes arising out of the building

of the Tilbury docks, and the claims arising out of the construction of a new branch of the Great Western Railway. He also had a large practice as a leader in compensation cases, and in references as to the value of undertakings acquired by public bodies.

By far the most important of this last class of cases was the arbitration to decide the value to be paid for the London Water Companies' undertakings, when these were acquired by the Metropolitan Water Board. The original claims amounted to £50,939,898, and Lord Moulton, who led for the Water Board, succeeded in reducing these to £30,662,323, a saving of over £20,000,000 to the London rate-payers.

Of all his cases relating to non-technical matters, I think Lord Moulton looked back with most satisfaction to the judgment obtained in the well-known case of *Peek v. Derry*. This case was the death-blow to the old fiction of "legal" or "technical" fraud. Shortly the facts were that certain directors had, quite innocently and in good faith, mis-stated in a prospectus the effect of a private Act. It was sought to make them personally responsible, on the theory that, as they had made a false statement on a matter as to which, in the eyes of the law, they *should* have known the truth, they had been technically fraudulent—though perfectly honest in intention. This view was upheld by the lower courts, and the defendants, for whom Sir Horace Daver and Mr. Moulton led, appealed to the House of Lords. Mr. Moulton, who both at the Bar and on the Bench was an inveter-

ate foe of such legal fictions, and particularly of those which imputed to a man motives known not to exist, put his case plainly and forcibly. "Every one of us," he said, "knows what fraud is. We know that it is not a matter of a legal quibble, but a fact implying personal dishonesty. We don't shake hands with a man who has been guilty of fraud." This view was adopted by the House of Lords, and the rule laid down, which has ever since been accepted, that to establish fraud you must show that the statement complained of was made with the knowledge that it was false, or without belief in its truth.

Lord Moulton would not have been considered a great "case lawyer," and quoted authorities comparatively little. He preferred to rely on the arguments which he thought appropriate to the matter at issue, rather than to quote a long string of previous decisions in cases resembling it. One of his maxims was that the most valuable cases to remember were those that had been wrongly decided; these might help in times of difficulty, while if you were right you should be able to convince the court by your own arguments without outside help.

His own view of the real value of a knowledge of previous decisions was given in an address to the law students at Liverpool:

"More and more one gets to realise that it is not in the multitude of the cases that one remembers that the strength of the value of one's judgment lies. The essential of advance is, that by studying the

cases—and it can only be done by study—you should have acquired a firmer hold of the principles underlying the decisions and a more unerring power of applying them rightly. It is this which represents the really valuable part of the knowledge that you have gained in your career.”

Lord Moulton's practice never extended into the Criminal Courts, with the exception of cases under the Merchandise Marks Acts, and other similar statutes, where what are virtually trade disputes fall to be decided by these courts. One of the last cases he had at the Bar was of this nature, the famous dispute as to “What is Whisky?” where a prosecution, brought in effect on behalf of those making whisky by the “pot-still” process, sought to have it declared that those who manufactured by the “patent still” process had no right to call their product whisky. Mr. Moulton was for the defendants, and his private, as well as his professional, feelings were very strongly on his clients' side, as he particularly hated indirect methods of opposing scientific progress in manufacture, and especially that method which depends on imputing wholly imaginary knowledge to members of the public, and finding that when they ask for an article by its common name they mean that article manufactured in a particular way, when in fact the ordinary buyer is absolutely ignorant of, and wholly careless as to, the mode of manufacture. For example, in the case in question it was shown that whisky had been

made by two different processes for nearly seventy years, since the patent referred to in the name "patent-still" had been taken out by Coffey in the first year of Queen Victoria's reign. This improved form of still effected a purification of the spirit by a single distillation greater than could be produced by many distillations in the old form, and the whisky so produced became fit to drink in a much shorter time than "pot-still" spirit. It was also proved that for very many years the greater portion of the whisky put on the market had been produced by the "patent-still" process. Yet, although for three generations purchasers had used the word "whisky" to cover spirit produced by either process, and had shown their acquiescence in "patent-still" spirit being termed whisky by continually repeating orders where it was supplied, evidence was gravely given that a purchaser using the word "whisky" meant a spirit containing certain percentages of impurities such as are only found in "pot-still" whisky. The magistrate actually accepted this contention and convicted the defendants, and before the appeal to sessions (in which the court was equally divided) could come on Lord Moulton had left the Bar for the Bench.

It may be mentioned that the Government recognised the grave inconvenience that this decision would cause to the public and the trade, and appointed a commission to inquire into the question, who in their report found that the word "whisky" was equally applicable to spirit made by either

process. The public were therefore left free to use this name as they and their forefathers had always done.

Previous cases of this kind had led Lord Moulton to the view that the Criminal Courts were an unsuitable tribunal for the trial of cases of this kind, where there was no question of fraudulent motive, but simply a contest as to the proper meaning of a name. He felt this so strongly that, when in the House of Commons, he introduced a Bill giving the High Court power to transfer such cases to the King's Bench on the application of either party, if it was convinced that the question to be decided involved a *bonâ-fide* trade dispute. He was not, however, able to get an opportunity of presenting this Bill for second reading.

Although, as has been stated, Lord Moulton never actually took part in criminal cases, he was offered one very interesting brief—that for the defence of Mrs. Maybrick. He was not, however, willing to take the responsibility of breaking such new ground in a cause where his client's life might depend on the verdict. He was always of opinion that the evidence in this case did not establish conclusively that Mr. Maybrick's death was caused by arsenic poisoning.

Many years afterwards his opinion was asked, in consultation with three other eminent counsel, as to the possibility of finding a process by which this verdict might be reviewed. The answer was, however, that there was then no method known to the law of questioning such a verdict.

From time to time Lord Moulton sat as Arbitrator, and he presided in this capacity over what were probably the longest proceedings of this nature on record. The dispute between the parties related to the value of certain coal mines in Wales, and it was agreed to submit the matter to arbitration. The first arbitrator died at the end of three years, and his successor only survived three months; it was, therefore, necessary to recommence all the proceedings before Mr. Moulton—who was the third Arbitrator chosen. The parties, who had agreed at the commencement that each side should bear its own costs in any event, sternly refused to allow the Arbitrator to do anything to shorten the proceedings—as, for example, by giving interim decisions on certain points—and said that if he attempted to do so, they would at once go to the court to revoke the submission, as was possible under the then prevailing practice. Mr. Moulton proved hardier than his predecessors, and at the end of eleven years gave his award, which was accepted by the parties. Of course the sittings were not continuous, but the Tribunal sat about thirty or forty times a year. Mr. (afterwards Lord) Robson represented one side, and his closing speech covered a period of two years. His opponents were represented by the well-known West Country solicitor, Mr. James Inskip, the father of Mr. T. W. H. Inskip, K.C.

Towards the end of his time at the Bar, Lord Moulton's advice was sought in relation to a very curious matter. Early in 1905 a number of patients

were admitted to the Manchester Hospitals suffering from a complaint which puzzled the doctors exceedingly. The symptoms were generally spots on the skin, and a loss of muscular power; in fact, with many of the sufferers who were draymen or omnibus drivers the first sign of the trouble was that they had not sufficient strength in their legs to apply the foot-brake. The natural curiosity of the doctors and students led to a number of questions being put to the victims, including queries as to whether and what they drank, and it was found that they all drank beer and patronised certain public-houses, which were all found to draw their supplies from the same brewery.

The result of these discoveries was an access of terror among beer-drinkers, and in order to allay this the brewers decided to appoint an independent committee to investigate the cause of the trouble, and to advise as to the best steps to be taken in order to protect the public and regain their confidence. No expense was spared, and a committee consisting of two medical men, Sir Lauder Brunton and Dr. Buckley, and two chemists, Dr. Stevenson, the famous authority on toxicology, and Mr. Gordon Salamon, was appointed with Mr. Moulton at their head, and given an absolutely free hand to make such investigations as might be thought necessary. By this time analysis of the beer from the particular brewery mentioned had shown that it contained considerable quantities of arsenic. It was also found that

all other beer examined was free from this. The committee then examined the materials used in this brewery, and found arsenic in the "brewing sugar," which is a preparation of starch or other carbohydrate which has been broken down by a mineral acid into the simpler sugars which alone are capable of alcoholic fermentation.

Investigations at the factory where this was made showed that the sulphuric acid used for the preparation of the brewing-sugar was contaminated. Now sulphuric acid is of two kinds—"brimstone acid" prepared from flowers of sulphur, and "pyrites acid" prepared from pyrites, i.e. iron sulphide. It is well known that acid prepared by the second method will always contain arsenic, which is present in the pyrites, unless it is freed from it by a special process. In order to avoid any risk the brewing-sugar makers had always stipulated for brimstone acid, but in fact had been supplied with pyrites acid which had been freed from arsenic. The great bulk of the sulphuric acid made by the firm from whom they obtained it, was used for industrial purposes, where the presence or absence of arsenic was immaterial, and this firm, forgetting that a portion was sold to brewing-sugar manufacturers, decided to omit the purification process, and so save apparently needless expense. Shortly before the brewing-sugar maker's chemist, who for many years had made routine examinations of the sulphuric acid for arsenic without ever finding any, had decided to drop this test. By this strange

coincidence (for it was nothing more) the arsenic was enabled to find its way into the beer.

It is curious to find that the suppression of the purification process, which led not only to the sufferings of those who were poisoned by the beer, but also to appalling financial consequences for all the firms concerned, was undertaken to effect a very small saving—about £100 per annum. The very smallness of the sum dispels any idea of collusion with those responsible for testing the acid at the consumers' works, since no sane men would have made the change to effect this trifling saving had they realised when doing so that part of the acid was to be used for the preparation of food-products, where detection of the arsenic was inevitable.

The natural consequence of these discoveries was an agitation for the prohibition of the use of brewing-sugars, which, had it been successful, would have seriously hampered our brewers in providing beers to suit the individual tastes of their customers. The commission, however, were able to recommend precautions which were recognised to be sufficient to prevent any danger in the future, and in fact to-day it is easier to guarantee that brewing-sugars are absolutely free from arsenic than it is to ensure similar purity in the case of malt, since the latter may absorb traces of arsenic in kiln-drying.

Lord Moulton's career at the Bar was cut short at the beginning of 1906 by his elevation to the post of Lord Justice. Lord Moulton became a Bencher of

the Middle Temple in 1889, Reader in 1900, and finally Treasurer in 1910.

It is a matter of the greatest regret that Lord Moulton was never able to store up the results of his legal experience for posterity in the form of a treatise on the Law of Patents. The only sources from which his views as to the principles which should govern the courts in dealing with patents for inventions can be derived are his judgments and certain of his addresses, which are dealt with in another chapter.

CHAPTER III

ON THE BENCH

THERE can be no doubt that the Court of Appeal was the most appropriate place for Mr. Fletcher Moulton. Had he been appointed a judge of first instance, it must necessarily have been on the Common Law side, which would have involved his trying criminal cases of which he had no experience whatever, as well as cases with juries, with which his acquaintance was comparatively small. But in the Court of Appeal he was able to devote all the powers with which nature and long experience had endowed him to trying cases which were largely matters of law, and in which the court were deciding principles important not merely in their application to the particular case then before them, but in their bearing on the general laws of the country.

During the six years that he sat as a Lord Justice, he devoted the greatest care to the preparation of his judgments, many of which were of the most elaborate nature. There was, indeed, at one time a tendency to criticise them as unnecessarily long, for on the Bench, as at the Bar, he always considered clearness as more important than brevity. And there can be no doubt as to the clearness of the judgments he gave.

There was no slurring or confusion between his judgment as to the facts of the particular case, and the matters which he considered as principles of law. And these principles he laid down distinctly and fearlessly, with as few qualifications or reservations as were possible.

This had the double advantage of facilitating the course of the party who might desire to carry the matter to a further appeal, and of rendering his judgments of real value as precedents for the determination of future cases.

There also grew up a legend that he was a very frequent dissentient from the opinions of the other judges of the court. I say a legend, for a comparison of his dissenting judgments with the total number of cases heard by him shows that in fact he did not differ from his colleagues more than the average judge, and where he did so his dissenting judgment was frequently upheld in the case of further appeal.

In one case such a dissenting judgment led to the final establishment of principles of the greatest importance in their effect both on the administration of justice and the rights of the public. This case, *Scott v. Scott*, arose out of a petition for nullity which had been ordered to be tried *in camera*. The successful petitioner—the wife—afterwards sent three copies of the evidence to friends to whom she wished to show that her action had been justified. The husband then moved to commit her and her solicitor, who had had the copies made, for contempt of court in pub-

lishing evidence which had been taken *in camerâ*. The judge found both guilty of contempt of court, and condemned them in costs. The case came to the Court of Appeal, and the appeal would have been dismissed without even calling on counsel for the respondents, but for Lord Justice Fletcher Moulton expressing his desire to hear the case in full (a course which by an unwritten law is always followed unless the court are unanimous), and he finally convinced his colleagues that the points raised were of such importance that the hearing should be taken before the full court of six judges.

The points for decision were three. Firstly, had the judge any power to order a hearing *in camerâ*, even with the consent of the parties? Secondly, whether such an order for ever prevented the publication of the evidence; and thirdly, whether a judgment on a motion to commit for contempt of court in disobeying such an order was a judgment in a criminal matter, in which case there would be no appeal.

Lord Justice Fletcher Moulton treated all these points as of the greatest public importance. If a judge could order a trial to be held secretly, if it were to be held an offence to ever state what happened at it, and if, moreover, there was to be no appeal against a conviction for such an offence, not only would the English principle of open justice be seriously endangered, but judges would to a large extent be rendered immune from that criticism which is often so salutary. He pointed out the wide effect of the

judge's decision, since it applied to every proceeding in chambers—for which *in camerâ* is merely the Latin equivalent—matters which in fact are openly discussed every day. Tracing back the practice of ordering nullity trials to be held *in camerâ* to the supposed procedure of the old ecclesiastical courts, he showed that no such procedure ever existed there, and he declared that the rule of the open door can only be broken by a court, when sitting as such,¹ in two cases—one where the case involves a secret process, so that to discuss the matter in public would defeat the object of the action, and secondly, where in some very exceptional cases a judge finds it impossible to proceed with a part of a trial in public. Further, with the exception of cases involving secret processes, he held that an order to hold a trial *in camerâ* meant just what it said, and that it did not and could not impose perpetual silence on the parties, that the alleged breach of the order was no breach at all, and that the motion to commit them “from a legal point of view might just as well have prayed that the appellants might be committed for contempt of court because in contravention of the order that the case should be held *in camerâ* they had acquired the habit of taking snuff.” He also held that such a motion to commit for contempt was no more a criminal matter than any motion to commit for

¹ He distinguished, as did the House of Lords, cases where the judges are acting in a tutorial rather than a judicial capacity, viz. cases where they are dealing with wards of court or lunatics.

breach of an injunction, against which there was an undoubted right of appeal.

However, he again found himself in a minority, four of the Lords Justices being against the appellants on all points, while Lord Justice Vaughan Williams was of opinion that the appeal did not concern a criminal matter, but gave no definite judgment on the other points.

The appellants lodged a further appeal to the House of Lords, and the matter was considered of such public importance that as the respondent (the husband) was unwilling to incur further expense, the Treasury appointed counsel to represent him. In this House, Lords Haldane, Halsbury, Loreburn, Atkinson, and Shaw, in a series of learned judgments covering 55 pages of the Law Reports, unanimously affirmed Lord Justice Fletcher Moulton's views and, by allowing the appeal, upheld the right of public trial.

Another important dissenting judgment of Lord Justice Fletcher Moulton was that given in the case of the Attorney-General *v.* the County Council of the West Riding of Yorkshire. The question in this case was whether the Education Act of 1902 which required Local Education Authorities to "maintain and keep efficient" non-provided schools, i.e. schools which had been built by various religious bodies, and in which the religious teaching given was denominational, imposed on such Education Authorities the duty of paying for the religious, as well as for the secular, instruction in such schools. It would seem curious

that such a point could arise, as the violent opposition which the Act evoked was expressly directed against the payment for such education out of the public rates, and it would, therefore, have appeared probable that Mr. Balfour's Government, which attached such weight to the provision of this religious education at the public cost, would have inserted clear provisions as to this payment. Nevertheless, the Act contained no such provisions, unless they were included in the duty to "maintain and keep efficient." Lord Justice Fletcher Moulton, although he had been one of the strongest opponents in Parliament of this State aid for religious teaching in these schools, decided that the County Council were bound to pay for this teaching, basing his judgment chiefly on the fact that the Act required both secular and religious teaching to be given in all schools, and that the school could not be "maintained" unless both were provided and paid for. The other judges of the Court of Appeal took a contrary view, and decided that the Local Education Authority was not bound to pay for this teaching. The case was carried to the House of Lords, where the court of eight Law Lords unanimously supported the views of Lord Justice Fletcher Moulton, and reversed the judgment of the Court of Appeal.

On several occasions Lord Moulton sat with Lord Justices Romer and Stirling, and so composed a court each member of which had been Senior Wrangler. Remembering that on an average there are not more

than twelve or fifteen Senior Wranglers alive of the ordinary judicial age, the fact that three of them were among the six judges in the Court of Appeal is a remarkable tribute to the fine training and testing, not only of mathematical ability, but of general capability, which the older curriculum for this Tripos afforded. I think Lord Moulton always regretted the change to the more specialised course which has been adopted, and the consequent abolition of the Blue Ribbon of the Cambridge University career.

The Court of Appeal is not a soil in which judicial humour flourishes, but one passage of arms between Lord Justice Fletcher Moulton and a very eminent counsel has been preserved by tradition, though it seems to have escaped the notice of the official reporters. The Lord Justice, having objected that there was no precedent for the views the learned counsel was propounding, was answered that "The Common Law is the mother of precedents." "Yes, Mr. —," came the reply, "but she is a mother who is now past the age of child-bearing." "With your Lordship's assistance," counsel promptly responded, "I shall hope to prove the contrary."

In 1912 Lord Robson resigned his position as Lord of Appeal, and Mr. Asquith appointed Sir John Fletcher Moulton to the vacant post, which he held until his death. But of this period of nearly nine years he was in fact only engaged in judicial duties for about three years, the remainder being

devoted to War Work and subsequently to his duties as Chairman of the British Dye-stuffs Corporation.

The time during which he sat as a Lord of Appeal was divided between the House of Lords and the Privy Council. The latter tribunal had a great fascination for him owing to the diversity and strangeness of the questions that arose before it, and of the laws by which these questions must be determined. Probably few persons outside the ranks of the law realise what a wonderful court this is, where a few judges bred up in the bosom of civilisation, and whose lives have usually been confined to dealing with the intricacies of modern law, have to decide questions relating to obscure Indian and African tribes, and decide them not as Western law would point, but by seeing through the eyes of the native, and following the views consistent with his customs and superstitions.

Among the cases heard by Lord Moulton in the Privy Council was a dispute as to the boundaries of the States of New South Wales and South Australia, which raised the curious point whether when a boundary is defined by means of a parallel of latitude, it is shifted when more accurate observation locates this parallel in a fresh position. The Privy Council here took the common-sense view that the boundary must remain fixed on what was considered to be the parallel at the date of the statute which delimited the States, and that the extent of the States, with all

the consequences (such as jurisdiction) depending thereon, could not remain at the mercy of every improvement science might make in geodesical measurements.

Another case of great importance—and the last case in which Lord Moulton delivered a considered judgment—was that of *Despatie v. Tremblay*. The case arose from the marriage of two Canadian Roman Catholics, and the subsequent application by the husband to have the marriage annulled on the ground that he had subsequently discovered that he and his wife were *fourth* cousins, i.e. that they had the same great-great-grandparents. The Bishop pronounced the marriage void according to the laws of the Roman Catholic Church, since the Lateran Council had declared in 1215 that marriages between fourth cousins must not be celebrated without a dispensation, and the Canadian courts had (by a majority) held that this made the marriage null at law. The case involved the most careful consideration of the provisions for the recognition of the Roman Catholic religion, and the protection of the rights and powers of ministers, contained in the treaty of 1763 by which Canada was ceded to England. This treaty and subsequent legislation had permitted ministers of each religion to solemnise a marriage according to their own customs, and the question which originally had merely affected a husband and his wife had developed into one which was considered as affecting the whole power of the Roman Catholic

Church in Canada.¹ The case was first started in 1910, reached the Privy Council in 1913, was referred back to the Canadian courts, and finally decided by the Privy Council in 1921. This final decision was expressed in a very full and clear judgment delivered by Lord Moulton in which it was held that although no minister need celebrate a marriage which was contrary to the laws of his Church, yet once the marriage was effected it was immaterial by what minister it was performed, and that since the parties were not in a relationship prohibited by the general law the marriage was valid.

¹ In fact the final judgment did not affect the original parties at all, since in the interval between the two hearings by the Privy Council the Roman Catholic Church had decided to permit marriages between fourth cousins and the parties had actually remarried.

CHAPTER IV

POLITICS AND SOCIAL WORK

LORD MOULTON first entered Parliament as Liberal member for Clapham in 1885, and immediately found himself at the division of the ways for the Liberal Party. He followed Mr. Gladstone, and was involved in the debacle of his followers at the next election, losing his seat by a majority of 447.

Although Mr. Fletcher Moulton voted with Mr. Gladstone and against Mr. Joseph Chamberlain on the second reading of the Home Rule Bill, he was in sympathy with the latter on the question of the retention of the Irish members at Westminster. But whereas Mr. Chamberlain and his followers considered it a question to be decided on the second reading of the Bill, my father thought the matter might be dealt with in committee. He had made his own position perfectly clear to the Prime Minister. On June 4th, 1886, he wrote to Mr. Gladstone as follows :

“DEAR MR. GLADSTONE,

“Many belonging to the Radical Section of the Liberal Party feel great difficulty in arriving at

the exact effect of the statements made by the Government and more especially by yourself at the Foreign Office and subsequently, as to the meaning of a vote in favour of the second reading of the Irish Government Bill and the extent to which it carries with it an affirmation of the specific proposals contained in that Bill relating to the mode of effecting and regulating autonomy in Ireland. And a further difference of opinion exists relative to the extent to which the Government intend to adhere to the provisions of the present Bill in framing the Bill which they propose to introduce in an autumn session.

“ The interpretation which I personally have given to the expressions of the Government in these matters is as follows :

“ 1. That in voting for the Second Reading of the present Bill one is affirming only the principle of the establishment in Ireland of a Legislative Body for the conduct of Irish as distinguished from Imperial Affairs.

“ 2. That the Government will consider and hold themselves free to accept any proposals made to them prior to the introduction of the Autumn Bill consistent with the five main conditions laid down by them as the essential principles of the solution of the question and their assurance as to the representation of Ireland at Westminster upon Imperial and reserved subjects.

“ The great gravity of the crisis and the paramount importance of a clear understanding as to the issue before the House lead me to ask you whether this interpretation correctly represents the position taken

up by the Government, and must be my excuse for thus troubling you.

“Yours most sincerely,

“J. FLETCHER MOULTON.”

To which Mr. Gladstone replied as follows :

“10, DOWNING STREET,

“WHITEHALL,

“June 4th, 1886.

“DEAR MR. MOULTON,

“I thank you for your letter, and will reply in brief but explicit terms to your two questions.

“1. I hold this to be indisputable and indeed elementary.

“2. My assent is again unequivocal, and I may add that a Government would not only be at liberty, but would be in duty bound to consider any such amendments.

“I remain, dear Mr. Moulton,

“Very faithfully yours,

“W. E. GLADSTONE.”

He unsuccessfully sought to enter Parliament in 1893, contesting South Nottingham and again being beaten by a small majority, but in 1874 he succeeded Sir Charles Russell—who had been made first Lord of Appeal and then Lord Chief Justice—as member for South Hackney. A curious feature of this election was the very close personal resemblance of Mr. Moulton and his Conservative opponent, Mr. Robertson. This likeness is recorded in one of E. T. Reed's sketches in *Punch*, “As like as two (M) P's.”

Mr. Moulton's taste for figures was immediately turned to account, as his return to Parliament was just before the introduction by Sir William Harcourt of the famous "Death Duty" Budget, and Mr. Moulton's powers were utilised to their full by the Chancellor of the Exchequer. Though he spoke little on the Bill, he had a great deal to do with shaping the modifications of the clauses which became necessary during its passage through the House and Committee. This is commemorated in a sketch by Sir Frank Lockwood.

Mr. Moulton's stay in the House was again a short one, as the Liberal Party were involved in another defeat in 1895. In 1899 he became member for the Launceston Division of Cornwall, which he represented till his elevation to the Bench in 1905.

Launceston had the largest area of any English division and a scattered population, chiefly agricultural, but including some miners and fishermen. As in 1899 there were practically no railways in the division, the task of conducting an election from his headquarters in the old capital of Cornwall was a very hard one, as a drive to a meeting and back might take a dozen hours. A campaign involved meetings in some forty different villages whose inhabitants all naturally wished to hear the candidate himself, as the electors were keenly interested in politics.

A very large part of the electorate consisted of Nonconformists, and this led to an amusing scene when Mr. Moulton came before the executive for

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MR. FLETCHER MOULTON EXPLAINING THE CHANCELLOR OF THE
EXCHEQUER'S BUDGET TO SIR WILLIAM HARCOURT.

A sketch by Sir Frank Lockwood.

adoption as candidate. Having been asked whether he was a Nonconformist, he replied that though not one himself, he had the greatest sympathy with their cause, and was referring to the prominent positions that various members of his family had taken in Wesleyan work, when he was cut short by a remark from the back of the room : " Seems to me as you're the only one as has gone wrong."

Probably Lord Moulton's most important political contribution up to this time consisted in two articles which were published in *The Contemporary Review* in 1894. These were written at a time when his party was naturally and justly indignant at the action of the House of Lords, which, refreshed by its habitual period of hibernation during the régime of a Conservative Government, had proceeded to reject the chief Bills sent up to it by the Liberal House of Commons. The Leeds Conference had just met and had passed a resolution for the immediate abolition of the Lords' power of veto, and every loyal member of the party was expected to take up this cry, though no means had been even adumbrated for the fulfilment of the object sought.

It needed some courage for a private member—and a very new private member—to cast doubts on the wisdom of a policy which had been so enthusiastically received by the party. But these articles dealt frankly with the impracticability (at that time) of effecting the full reform desired, and suggested practical steps which were more easy of fulfilment.

The first article, "The House of Lords—a plea for deliberation," was directed to the need for further consideration and preparation before embarking on this great constitutional struggle :

"My plea therefore is for deliberation. A celebrated mathematician said that if his life depended on solving a particular problem in five minutes, he would devote at least two to considering how to set about it. Let us imitate him, and give to the country and to ourselves the necessary time and reflection before we commit ourselves to any course of action. The delay of deliberation is far less than that of defeat."

He then pointed out the impossibility—or at any rate the improbability—of the electorate accepting a suggestion which would amount to a single-chamber rule, unless it was accompanied by something in the nature of a written constitution limiting the arbitrary power of that chamber.

"If we forthwith go to the country upon the question, it must be put in the crude form of abolition either of the House or its veto. No schemes for safeguarding the nation under the unique form of government that would result are so widely known or so generally accepted as to be regarded as a part of the proposal. Its novelty will give room for prophecies innumerable of likely and unlikely consequences, the inevitable result of which will be to produce a feeling in the minds of the more cautious that it is a matter which at all events requires to be thought over before

action is taken. . . . I do not lose sight of the imperative need of getting rid of the interference of the House of Lords, but I should despair of achieving it within a period of very many years, if I thought that we had no better course open to us than to appeal to the country to give us authority to put the whole kingdom under a single omnipotent chamber—with six years of Tory administration as the penalty for each failure.”

He next proceeded to his own more moderate scheme, which was to develop a system of Federal Government, treating Home Rule for Ireland as merely the first step in this, by which local questions should be dealt with by single-chamber local Parliaments whose measures should be subject, not to the veto of the House of Lords, but only to that of the Imperial Parliament as a whole, so that the House of Lords would be powerless to impose its veto unless the Commons agreed. In this way local questions would be largely, if not wholly, decided by those directly affected, since the two Houses of the Imperial Parliament would not lightly combine to thwart the wishes of their representatives, while at the same time a safeguard would be provided against mad legislation by the local bodies without the need of rigid constitutions for the new States, or the second chambers of weird composition which it had been from time to time proposed to set up in them. In his opinion such a scheme had a far better chance of being accepted than any Bill for the direct abolition of the veto.

“Nor would the resistance of the House of Lords be so desperate or so unanimous. . . . The Peers know that their powers exist by sufferance based largely on the difficulty of getting rid of them. This is no too solid foundation, and they cannot be indifferent to the dangers which threaten them. A timely and judicious concession to a well-prepared federative scheme might turn aside the storm without any formal sacrifice of their position in the Constitution. It would not be accomplished without a hard struggle, but it would not be one in which no alternative existed between victory and annihilation. The maxim of building a golden bridge for the enemy applies pre-eminently to politics.”

To those who objected that this only mitigated the mischief of the veto his reply was :

“The veto would be effectively abolished for the whole of the most important part of our legislation, viz. that which affects the internal questions of the nations that compose the United Kingdom. And it is precisely in this kind of legislation that the power of the House of Lords is most baneful. In foreign and Imperial questions their influence is less potent and less harmful.”

He further showed how, if the burden of local administration could be removed from the Imperial Parliament, the House of Commons could devote itself far more effectually to any further struggle it might deem necessary as to the alteration of the powers or constitution of the Upper House.

“ At present we should do it at the cost of stopping all the necessary domestic legislation of the three Kingdoms. . . . An engineer would know that if he had to reconstruct the engine which drove a mill without stopping the mill, he must throw the work on supplementary engines. He could not reconstruct it while it had to do the whole work of the mill.”

Unfortunately the cry for immediate action prevailed, and the Liberal Party paid the penalty predicted. Had these counsels been accepted, much of the bitterness of the constitutional struggle that followed that party's return to power might have been avoided, and the question of local self-government, for Ireland and other parts of the kingdom, solved in time to prevent the troubles that have arisen.

His second article, “ The House of Commons—a plea for action,” dealt with the equally crying need for reform in the procedure of the House of Commons, and suggested means for facilitating legislation there, many of which have now been adopted. Most of these suggestions had the great practical advantage that being matters of procedure in the House of Commons itself, they could be brought into force without the consent of the Peers. The awful waste of time imposed by the necessity of recommencing from the beginning the work on Bills which had not been completed in a single session, or which had been rejected by the Upper House, should be saved by rules which enabled the earlier stages of a Bill when

reintroduced to be avoided or formally dealt with without debate, and the still more terrible power which individuals had of wasting the time of the whole House curtailed by giving that House power to say when discussion on any point should be terminated. These steps, it was pointed out, would materially assist the Commons in their contest with the Peers :

“ If they [i.e. the various measures on the Liberal programme] had been passed through the House of Commons and sent to the Lords, the bulk of them must have become law.† It is easy to find special reasons to excuse the rejection of one or two particular Bills, but to reject the bulk of the measures constituting the programme upon which one of the two great parties in the State obtained a majority in the Representative House can bear but one meaning, viz. that of a formal refusal to bow to the decision of the people expressed in due constitutional form, and this is a step from which even Tory Lords would shrink.”

The spirit in which this second article was written throws considerable light on Lord Moulton's Parliamentary career, and probably explains why he did not achieve even greater success in the House. To him waste of time, whether his own time or that of other people, was anathema. Now, according to political tradition it is the business of the Opposition (and most of Lord Moulton's Parliamentary life was spent in Opposition) to waste time and so delay the passage of legislation which it dislikes. Lord Moulton always found this process most distasteful. He

would oppose a measure by argument, not by delay, and if it were clear the Bill would pass would seek to make it as good a Bill as possible. He would never have become one of the "old hands at the game" whose reputation depends so largely on their knowledge and use of dilatory procedure.

It was unfortunate that by far the greater portion of Lord Moulton's political life was spent in Opposition, where his talents had no chance of being applied to real legislative work. During the latter part of the 1900 Parliament the vitality of the House of Commons sunk very low; the Government, divided among themselves as to future policy, confined their energies to pushing through various items of their programme with as little argument as possible, by the votes of members many of whom were careless of the future as they knew they had no possible chance of re-election. Many of Mr. Moulton's speeches during this period attracted considerable attention, but I will only mention one, that opposing the Chinese Labour Ordinances. The main point of his attack was that these Ordinances, far from developing the Transvaal, would inevitably stunt its progress. I give one extract :

"How have we got it [South Africa]? By conquest. But you cannot keep it by conquest. You must keep it by colonisation. Everyone who has thought out the whole matter of the future of South Africa knows that its prosperity depends upon the way in which we bring colonisation into that country,

in order to tie to us by consanguinity that which has been acquired by conquest. How are you going to do it? You can only do so by using the great mineral wealth of the Rand for the purpose according to sound principles of Government—namely, by letting the industries of the country collect round themselves a working population fit to form the nucleus of the future nation that you hope to see arise in that country. You have got in the millions to be raised from the Rand the materials for attracting such a population, but . . . you are going to allow these mines to be worked by people whom you will not permit to be citizens of the future country. If, on the other hand, you choose to work the mines by white labour . . . you will attract an enormous quantity of white labour which will form the nucleus of the future inhabitants of South Africa.”

Of course this controversy, like so many others in Lord Moulton’s life, is now a dead thing because his opponents have ceased to exist, but the prophecy with which he closed his speech—“there is not one honourable member who will vote for this Ordinance who will not bitterly regret it in after life”—must have often recurred to those opponents when they faced the Electorate in 1906.

In 1905 Mr. Moulton attempted the task of getting a Bill to amend the law relating to Trade Marks through the House single-handed. His long experience at the Bar had convinced him that an amendment of this law was urgently needed, and that the legal views as to what Trade Marks should be regis-

trouble were grievously out of step with the views held on this subject by commercial men and manufacturers. Seventeen years had passed since the last attempt to amend these Acts, and the great developments in commerce that had occurred during that time had only made more marked their original inadequacy. Many marks which every honest trader throughout the world recognised as the property of a particular British house were denied the right of registration by British law. This not only had the direct effect of denying to the owner of the mark protection in this country, except by the cumbersome and expensive action for "passing off," but it also had the even more serious indirect effect of preventing him from obtaining protection in foreign countries, since these generally refuse to give protection to a foreigner's mark unless it is registered in his own country. The most important change which the Bill proposed was the abolition of the rigid boundary fixed by the earlier statutes between "descriptive" and "distinctive" words. If a word could be held to be in any degree descriptive of the character or quality of the goods, registration must according to these Acts be refused. But in fact many such words have come to be recognised as indicating the goods of a particular firm, and the Bill therefore gave to the courts for the first time a power to examine whether a word originally "descriptive" had become "distinctive" through use, and if such were the fact they could in their discretion admit it to the register. This

power extended to all word marks so that surnames and geographical names, which were before unregistrable, might in proper cases be protected.

Many other amendments, all based on practical experience, were included. For example, colour was for the first time recognised as a possible element of distinctiveness. The Bill, indeed, was a very long one, having seventy-four clauses in all.

Those who know the procedure of the House of Commons will recognise what a formidable task it was for a private member (and on the Opposition side) to pilot such a Bill through the House. Many of the stages had to come on at times when only unopposed business could be taken, and when a single "I object" could stop all further progress. There were certain members of the House who considered, rightly or wrongly, that they were performing a public duty by preventing legislation at such times; there were others ready to oblige any constituent who might object to a provision in the Bill. All these dragons had to be pacified if the measure were to become law, and in addition the objections raised by various outside bodies such as the Chambers of Commerce had to be considered and met, or their proposers persuaded to abandon them. Luckily this last task was one for which Mr. Moulton was particularly fitted. He had a maxim that you could generally "get success if you did not want victory," and he managed to satisfy most of these objectors without sacrificing any material provisions in the

Bill. Finally the long string of clauses were allowed to pass (though a certain prominent politician told Mr. Moulton that he had had to exercise the severest self-control to restrain himself for so long a period from uttering the customary formula of objection) and the Bill proceeded to the easier waters of the Upper House, and in due course became law.

There can be no doubt of the improvement effected by the Trade Marks Act 1905, and many hundreds of marks known all over the world have been put on the register under its provisions. The recent Act of 1917 has given even wider scope to some of its provisions, as experience has shown that the fears which some of the more timorous entertained as to their effect were unfounded, in particular the Registrar had now been given the power, which the earlier Act confined to the courts, to admit word marks on proof that they have become distinctive by user.

Probably Lord Moulton's greatest personal triumph in the House was on the occasion of the reading of a private member's Bill—the so-called "Pure Beer" Bill. The chapter of accidents which had led to the Manchester beer poisoning was looked on as a providential circumstance by some of the agricultural members of the older school. If they could use this lever to force the brewer back on malt and hops as his only materials it would have been in their opinion a great triumph, since English barley is particularly suitable for malting. The Bill in question came on

for a second reading in 1904, and its sponsors expected an easy passage through that stage, since a similar, though not identical, Bill had been given a second reading in the last session by a very large majority. The debate had proceeded for some hours when Mr. Moulton rose to oppose the Bill. It was an occasion somewhat rare in the House of Commons when, there being no Government Whips on, and a very large number of members having given no pledge either way, the House is open to be convinced by argument, and Mr. Moulton used this opportunity to the full.

Dealing with the history of English brewing, he showed into what difficulties brewers had got by blindly adopting "natural processes." Nature in elaborating the process of "malting"—or the conversion of starch into fermentable sugar—had no thought of brewing beer, but only of producing easily digestible food for the growing germ. To ensure this she provided a surplusage of malt—far more than was required to convert the barley. The presence of so much malt was prejudicial to the beer, and led to such heavy "hopping" that over-indulgence caused narcotic poisoning. Research had shown how to avoid this by only malting a portion of the barley, and by adding already converted sugars.

Beers so brewed, at first introduced from abroad, had so pleased the public's taste that they demanded this lighter and pleasanter beverage, yet the whole object of the Bill was to prevent the brewers from

profiting from this research, and giving their customers what they desired.

Of course this analysis was very distasteful to those behind the Bill. The title of their measure was a good one—the “ Pure Beer ” Bill suggested that they sought to protect the public from adulteration, and they naturally considered this full description of its objects and effects if passed ill-timed and inconvenient. There were a large number of members who knew nothing about beer, who probably did not drink it, and who might be counted upon to have a sentimental feeling for the good old English beer, if only from the references to it in our songs and literature and the pictures of jovial red-faced huntsmen quaffing it from brimming tankards. These votes they saw disappearing with every sentence that came from the unsentimental and terribly well-informed member for Launceston.

But they found that he was not without sentiment, and he put in a plea for what was nearest his heart—the untrammelled progress of science. He showed how, when an industrial art passed to a science, and was developed out of sight of the old-fashioned methods which had usually been elaborated by those quite ignorant of their rationale, the more the manufacturers improved their methods, the more they were open to attacks from the ignorant, attacks based on a misapprehension of what the newer processes really were. It was a real stumbling-block in the development of inventions that a manufacturer always had

to consider whether if he took up a new invention and made it a success, he would not be harried by these attacks as a reward for his enterprise. So, too, it was constantly thrown in the teeth of inventors that the time would come when their inventions would be adjudicated upon by those who knew nothing about them.

He concluded as follows :

“ These are refinements which nobody dreamt of until the science of fermentation had made these advances, and now science gives to the brewers not only cheapness, quickness, and better quality, but also that what always accompanies the growth of science—greater certainty. They have become musicians who can play on the keys of the instrument and produce the result they want. Do you mean to tell me that it is a good deed to send us back from this state into the ignorance of the past. Why, it brings to one’s mind those two lines of Shakespeare where he refers to limits sought to be imposed even in his day.

“ ‘ And Art, made tongue-tied by authority,
And folly doctor-like controlling skill.’ ”

The chief supporter of the Bill who followed practically confessed that he could not answer this speech, and was reduced to pathetically repeating that if only the House would pass the Bill, the farmers could put up the price of barley by seven shillings a quarter. Even this argument did not have the required effect, and the Bill was thrown out by a substantial majority.

I have given this somewhat lengthy description because Mr. Moulton was told by some of the older Parliamentarians that it was the only occasion when they had seen a single speech turn the House.

Mr. Moulton's services, while in Opposition, had marked him as an almost certain candidate for Ministerial honours, but another career was reserved for him. One of the very first of Sir Henry Campbell-Bannerman's actions as Prime Minister was to offer him a seat in the Court of Appeal—an unprecedented promotion for one who had not been a law officer.

So Mr. Moulton disappeared from politics till his elevation to a Lordship of Appeal in 1912 brought him to the House of Lords.

This termination of Mr. Moulton's career as member for Launceston was in accordance with the traditions of that division, which seemed fated to be a stepping-stone to high judicial honours, as both Lord Halsbury and Lord Alverstone had been members for the Borough.

My father was an Imperialist of the broadest and most unselfish type. He looked on the British Empire, and more particularly its government of uncivilised or backward countries, as the greatest influence for good which the world had ever known. To him our real justification for the occupation of Egypt was not based on controversial interpretations of treaties, but on the fact that, for the first time in its six thousand years of history, the peasant got as a matter of course his fair share of the life-giving

waters of the Nile. The main points to which he looked in our record in India was that that great Peninsula of heterogenous peoples had enjoyed substantially a century of peace, justice, and prosperity, that famines had ceased to have their old terror, and that, to take one example, the irrigated land in the Punjab had increased fivefold in the last fifty years. I know that this method of judging a Government by its effect on the lives and happiness of those whom it rules is unpopular with the modern school of philosophical historians, but I am giving Lord Moulton's views as they were. It must be remembered that he was a man singularly free from the domination of phrases, and an appeal to such magic formulas as "self-government" or even "self-determination" left him untouched until he had examined the actual facts. Nor did he consider that the circumstance that a certain percentage of the population of a country had been taught to read and write justified us in neglecting the teaching of the whole history of that country as to what would be the probable course of future events once the restraining hand of Britain was withdrawn. The argument that we should be morally justified because a popular agitation had been raised for self-government left him singularly unmoved. Pontius Pilate was a character for whom he had little admiration, and he held that a nation who had accepted a responsibility was no more justified in washing its hands of it than would be an individual in similar case. He thought, rightly or

wrongly, that history showed that the British administration had been singularly successful in Africa and the East, and held that if providence had given to us the faculty of bringing prosperity and peace to nations there, that talent must be used to the full.

The absence of respect for names and phrases as such extended to other departments of politics. A lifelong Free Trader, Lord Moulton refused to look on Free Trade as more than a matter of expediency, and never adopted the Pharisaical attitude that the system of protection in use by all other nations, and by our own Colonies, was morally wrong. In his opinion Free Trade was generally more profitable to this country, and he particularly objected to any protective measures that would excuse our manufacturers from adopting the most up-to-date methods. But regarding the question as one of national expediency, he was always willing to examine whether there was a case for an exception to this principle, as he showed in his proposals for a limited protection of our chemical industries.

Lord Moulton's general views on political economy were based on the benefit of increased production. If production of an article could be facilitated so that there was more to go round, each worker must in the end get more. There might be difficulties or abuses in the process of distribution which for a time might deprive the ultimate consumer of the benefit of the increase, but he always considered that these were but temporary obstructions, bound soon to be swept

away, and of quite minor importance. He was more convinced of the benefit that invention and organisation of production conferred on the working-classes, because he saw that these were mainly directed to the manufacture of articles of general consumption. He expressed his views on this point in an address to the Liverpool Philomathic Society :

“Remember that the whole development of production under the influence of steam has been in favour of the many and not the few. Steam cannot work for the few. Machinery will not labour for the single individual, but no sooner has a thing become a general want, than it can be turned out by machinery in such profusion and comparatively at such little expense that you cannot get a market for it till you go to those classes which are numerous—that is to say, the classes which are doing the direct work of our industrial system. From the first steam has always been the great friend and the great protector of the working-classes, though they have often failed to recognise the fact, and I am satisfied that if we could only teach these classes that the sole source of remuneration is production, if one could make them once feel that the lessening of production is the lessening of the effective money that is to buy that which they are consuming, we should have their co-operation in the endeavour to develop production, and we should have more than half solved the problems which make so many a brow clouded to-day.”

He was therefore in politics as in science the persistent apostle of cheapness, in the sense which he

always used the word—production with the minimum of labour—and he felt instinctively that any action which opposed cheapness of production—from whatever quarter that action came—must be prejudicial to the general good. He was therefore a strong supporter of the general principle of Free Trade, which would permit each nation to benefit by production under the conditions most favourable to cheapness, unless there were very real advantages to be obtained from a contrary course. Equally was he opposed to any restrictions which tended to prevent maximum production, and he looked on the worker who deliberately diminished his output as the equivalent under peace conditions of the coward in time of war.

I would again emphasise his definition of cheapness—production with the minimum of labour. It had nothing to do with wages paid, except in so far as they were a fair measure of the labour used. He was always a strong supporter of the efforts of the workers and their Unions to ensure that the wages paid should be adequate for the work done; where he did criticise the Unions' action was in the excessive rigidity applied to the minute classification of labour. Progress in economic production must inevitably mean some displacement of labour, and he naturally wished every facility for its re-employment in other fields.

My father's life had been long enough to enable him to see in fact the improvement in the standard

of living of every class which modern science had effected, and all that he saw made him the more ready to fight for its untrammelled progress, whether the opposition to that progress came from a mistaken view as to its effect on the interests of the working-classes, or from manufacturers who were unwilling to change their traditional methods and sought by indirect means to prevent the introduction of more efficient means of production.

While in the House of Lords Lord Moulton took little part in controversial politics, partly on account of his judicial position and also because, for the greater portion of the time, his war work left him little leisure for anything else. He was, however, frequently consulted by the Government as to Bills dealing with legal and technical matters.

Perhaps the best description of Lord Moulton's political views—using the word in its broadest sense—will be found in a somewhat strange setting—a short after-dinner speech at the Authors' Club, delivered in 1912, in which he chose for his subject "Law and Manners." In it he divided the range of human actions into three parts, the domain of Positive Law, the domain of Free Choice, and between the two came the region of Manners, "the domain of Obedience to the Unenforceable" where each of us enforced on ourselves a law we could not be made to obey.

Lord Moulton described himself as one who throughout his legal and judicial life had acted as a com-

missioner for delimiting the frontier dividing this realm from that of Positive Law, for deciding whether the law could say you must, or had regretfully to say "I leave it to you." But he in no wise wished to extend the area governed by law. Each region was necessary; law must exist, whilst the region of free choice should be dear to all, since it was where spontaneity, originality, and energy were born and where great movements which make history started—a place where a man was not only entitled to do as he would, but had the right to claim freedom from criticism. To his mind the real greatness of a nation—its true civilisation—was measured by the extent of this law of obedience to the "unenforceable" far more truly than by the extent of its obedience to positive law, which might merely show a strong executive and a timorous people.

It must be remembered that this was said before the war, so Lord Moulton could not appeal to the strongest illustration of his theme—how little the laws by which so many things were "Verboten" had served to form a really great nation.

Lord Moulton said he feared lest some modern democracies might seek unduly to limit this land. There were too many who thought that the power and will to legislate in itself justified legislation. Such a principle would be death to Liberty.

To his own mind he defined "tyranny" as the "lust for governing." Once this prevailed, no action in life would be free from outside interference. A

majority in our system of government had absolute power to make laws, but it too should yield obedience to the "unenforceable," and feel it an honourable duty not to step beyond that which was in reality, and not only in form, put into its hands.

Much also might depend on the other boundary of this domain, where it marched with the region of unrestricted liberty. Lord Moulton instanced the case of modern Trade Unionism, with its immense powers practically untrammelled by law. Whether this might become dangerous, even disastrous, depended on whether those who had gained this freedom would treat it as something to be used arbitrarily, or whether they would recognise that though free from the enforceable law, they were yet subject to the unenforceable. He was not afraid to trust the people, provided they recognised the trust. He concluded as follows :

" It must be evident to you that I intend Manners to include all things that a man should impose upon himself—from duty to good taste. It is because I have borne in my mind the great motto of William of Wykeham, 'Manners makyth man.' It is in this sense—loyalty to the rule of Obedience to the Unenforceable throughout the whole realm of personal action—that you should use the word 'manners' if you would truly say 'Manners makyth man.' "

I think that this speech furnishes the key to Lord Moulton's true views on many matters. He hated

unnecessary or excessive legislation—firstly as an undue and dangerous infraction of individual liberty, and secondly because the results obtained by such legislation did not better the true spirit of the people—rather it worsened it by removing the need for self-discipline. But above all he recognised, and wished all others to recognise, that many actions which may seem to be unfettered are really “under the sway of duty, fairness, sympathy, taste, and all the other things that make life beautiful and society possible.” A high creed, but one that he ever followed.

Lord Moulton always took the greatest interest in Education, and was for very many years a member of the Senate of the London University. Here he had a very special care for the interests of the external students. In his view some of the most valuable functions of London University were those in which it acted not as a local place of education, but as a National or Imperial standardising centre, which would certify to the knowledge and abilities of the students who presented themselves for its examinations, irrespective of the circumstances under which such knowledge might have been gained.

In recent years there has been a very strong reaction against examination as the governing test for educational qualifications, and a tendency to give greater weight in the award of degrees to regular attendance by the student at courses organised at Universities and elsewhere. There can of course be no doubt that

these afford the easiest and most favourable lines of development when it is possible to follow them. But Lord Moulton recognised that they were not the only roads to knowledge, and thought that the man who had the pluck and ability to follow the more stony paths of private study had an equal, if not a greater, claim to recognition if he reached the goal of knowledge. He never forgot his own experience in the days when he was studying for the University in the intervals of his work as a teacher, studying alone and unaided for a competition in which most of his rivals had been prepared by careful and competent instructors. To him when he entered Cambridge it was almost a revelation that from henceforth he should have new subjects explained to him, and that there would always be someone to whom he could turn for help in moments of difficulty, and he has confessed to his surprise when he saw that all those around him took what to him was a wonderful new thing as part of the ordinary course of nature. Consequently he always had a soft spot in his heart for the private student—the “ranker” of the educational world, whose sole qualifications are the deeds by which he has proved his knowledge.

In his evidence before the Royal Commission on University education he emphasised this view strongly. Asked whether he would say that a student who had had no University instruction should be classed as the equal of one who had, merely because he had attained the same standard in an examina-

tion, his answer was : “ No ; I should say the private student was probably far the better man, since he has attained this standard without the advantages which his rival enjoyed.” Of course there is no paradox in this, nor does it involve any depreciation of organised instruction, of which Lord Moulton, as his addresses show, was a strong advocate. Such instruction will generally bring out the best in any man, and had the private student referred to above had its aid he would probably have attained to a still higher level than he actually reached, but in Lord Moulton’s view he was none the less as fully entitled as his rival to the degree or diploma appropriate to the knowledge he had shown.

The actual abolition of the examination for external students was never directly advocated before this Commission. It was rather a question of seeing that their interests were not indirectly affected by a difference in the standards insisted on in the external and internal examinations. It was necessary that these should be separate, since the authorities wished their own internal examinations to bear directly on the instruction given in the preceding terms, and much of Lord Moulton’s effort was directed to seeing that, as far as possible, the test for external students should be equal to, but not higher than, that imposed on internal students.

The importance of a central standardising University such as he advocated should not be underrated. In the great majority of cases a degree—

whether in Academic or Technical subjects—has a distinct commercial value to its possessor. This tends inevitably to some Universities lowering their standards so as to attract more students, and it becomes very difficult to estimate the comparative values of different degrees.¹ Hence comes the call for a central standardising authority from which a student, wherever he may have studied, may obtain a hallmark as to whose signification there can be no question.

Lord Moulton was not an advocate of a great extension of compulsory education. He had no belief in the theory that all men are born equal when this is pushed to the point of saying that all have equal abilities, or are equally capable of profiting by an extended education. The idea, now put forward in some quarters, of whole-time compulsory education to the age of sixteen or even eighteen would in his opinion have led to no return at all commensurate with the expenditure of the teachers' and students' time, and the nation's money. But he was prepared to make the greatest sacrifices to help those who showed their desire for education by their willingness also to make sacrifice of their leisure time, and accordingly he took the liveliest interest in that great system of voluntary education embodied in our Evening Schools. He loved the men who were always trying

¹ Of course this is shown most strongly in the United States, where there are a multitude of Universities to whose degrees little real weight attaches.



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to rise, who did a full day's work at their present job, but had energy enough to seek in addition the education that would broaden their interest in life, would enable them to rise in their grade of work, or qualify for a better or more congenial employment. I think he always felt that those who were really fitted for further education would find the time to obtain it.

But for those who were taking up technical employment he advocated the most thorough education in their trade or profession. He frankly expressed his opinions that this country was far behind in this respect, and he had no faith in mere workshop experience for repairing this deficiency. In his opinion those who merely depended on this made progress only at the cost of exorbitant expenditure of time and trouble. In one address he put this point as follows :

“Let me try by another parallel to impress on you how great is the difference between the position of those who have and those who have not received technical education. Suppose two ships were running an ocean race, say through the Straits of Magellan to Australia. When they get to the Straits of Magellan it is found that one captain has a chart which shows him the rocks, and the other has to go on sounding, sounding, sounding in order to bring his ship safely through. The work that he does would have been smart seamanship two centuries ago, and would probably have led to a profitable return, but to-day it is past its day and must lead to failure. The one who has got the chart has only to look at the chart to learn all that the other competitor arrives at by

labour and care, and hence he is at his journey's end before the other has faced half his dangers."

Nor did he think that technical education should be confined to those in the higher ranks of industries or professions. He took the view that by suitable education every workman could be brought to produce more work or better work—and to his mind such a result was the worker's duty to a nation and to himself as well as to his employer. He greatly regretted the lapse of the apprenticeship system, where, at any rate in theory, some effort was made to give the beginner real instruction in his trade. I think that he hoped the new continuation schools would help us in this direction by teaching beginners something of the science of the work they were doing—the "why" of the process of which they only learnt the "how" in their workshops, and also instilling knowledge, such as how to make or read a plan, which at present is considered to be the mark of the foreman class. If you could raise your workers' capabilities to those of the present foremen, he had no doubt that the other grades would also make a move in the upward direction.

Lord Moulton was one of the first Aldermen of the London County Council, being nominated by the Progressive Majority in 1889 and sitting till 1892.

CHAPTER V

LORD MOULTON AND SCIENCE

MY father's life was full of work and interests of the most varied description, to each of which in turn he gave of his best. But amidst all these calls on his time and energies he ever served, willingly and devotedly, his mistress Science. That the services he so rendered were purely honorary, that they had to be superimposed on duties which most men would have thought more than sufficient to fill any life, detracted neither from the work he gave nor, except as to quantity, from the value of that work. Great as was his success at the Bar and on the Bench, there were many of those best able to judge who regretted that his life had not been wholly given to science, and it may well be found that what he did for her cause will have the most lasting effect.

In writing his life one must, as in the case of any other scientist, attempt to give, with such adequate detail as space permits, an account and explanation of the work he did. Those who knew his charm as a scientific speaker will regret, as keenly as I do myself, that he could not himself perform this task, for in his hands the dry bones of science were ever clothed with living flesh.

Neither at school nor as an undergraduate did Lord Moulton have any opportunity of indulging in experimental science. When he went to Cambridge the Science Tripos, although in existence, was held as of small account, and the laboratory facilities were on a very restricted scale. Electricity was not then even included in the Mathematical Tripos, though it was a subject for the examination for the Smith's Prize which he took soon after.

His first scientific work was as an astronomer, as he was invited by the Government to form part of Professor Tyndall's expedition to Spain to observe the total eclipse of 1870.¹

While still at Christ's Lord Moulton had a controversy with the then fashionable philosopher Herbert Spencer, which attracted a good deal of attention at the time. Spencer had left the realm of philosophy and metaphysics, and was attempting to deal with the laws of physics—and in particular of mechanics. His method largely consisted in classifying certain ideas or phenomena as inconceivable, whilst others, such as certain of the laws of motion or the conservation of energy, which the poor physicist fondly imagined to be based on observation and experiment, were declared to be drawn from our own inner consciousness. For example, in regard to the principle

¹ He was much amused by the directions with which he was furnished for making the observations in question, which commenced with "First take the cap off telescope." This was a legacy from a former expedition when an excited observer had omitted this essential preliminary.

of the "Persistence of Force"—otherwise the conservation of energy—(which incidentally is a generalisation of observed phenomena and which was only recognised comparatively late in the history of science) Spencer says: "Deeper than demonstration—deeper even than definite cognition, deep as the very nature of mind, is the postulate at which we have arrived. Its authority transcends all other whatever, for not only is it given in the constitution of our own consciousness, but it is impossible to imagine a consciousness so constituted as not to give it."

This was the sort of pseudo-science that my father could never tolerate. He always emphasised that science and scientific progress must depend on experiment and observation, and these attempts to hallmark certain of the deductions drawn by scientists as derived from some higher source could, he knew, only lead the reader to rely on utterly false criteria. In a most trenchant review published in *The British Quarterly* he mercilessly dissected certain of the author's statements relating to physical matters, showing how many of the apparently brilliant deductions arrived at depended on the use of phrases such as the "Persistence of Force" in half a dozen different senses. Lord Moulton's summing up of this process of deduction is as follows:

"Some other signification (we scarcely know what) which the words will bear is given to them, and out of

the vague and general proposition which was granted him pour forth propositions of the most exact and definite kind. . . . Never did a juggler's inexhaustible hat stand him in better stead. And the effect of such writing upon the thoughtful readers is, after the first surprise, much the same as that of the prestidigitator's feats upon his audience. They may admire the skill with which he conceals the *modus operandi* of the trick, but, whether they trouble themselves to detect it or not, they feel none the less certain that the countless articles that pour from it were not in the hat when they gave it to him."

In other instances the reviewer was able to show that the "infallible" deductions led to results utterly at variance with observed phenomena.

Naturally the article led to a rejoinder and this to a counter-rejoinder. The whole controversy is now dead, and it is difficult to imagine a similar one occurring to-day, for the experimental foundation of all scientific laws is such a well-recognised fact that we could hardly imagine recourse being had to even the most eminent metaphysician to give his seal to scientific truths. Even such a revolution of all our most fundamental ideas as the Einstein theory is discussed by the educated world according to the true criterion—how far it and it alone explains observed phenomena. But it is well to remember that this was not always so, and this article is worthy of mention—apart from its being the first of Lord Moulton's publications—as illustrative of the period

when the modern school of scientific thought and teaching was establishing its supremacy.

At this time the struggle was by no means over, in fact the experimental method of scientific instruction had still many opponents. Lord Moulton used to tell how Isaac Todhunter, the famous mathematical writer and one of his contemporaries at Cambridge, who was an opponent of the experimental mode of scientific instruction, said to him once: "If a boy is told a scientific fact by a person of responsibility—say by a clergyman—he ought to believe it and not want to see it for himself." At such a time it was all-important that scientific teaching should be kept on the clearest and soundest lines, and Lord Moulton rendered a real service by striking at these attempts to divert the learner from the true principles of science into a maze of ill-defined phrases and imaginary principles, and preventing that infant science, which now dominates the world, from being stifled by the swaddling-clothes in which officious friends sought to involve it.

Incidentally the article contained some valuable statements of Lord Moulton's own scientific views. To him a scientific "law" was a generalisation of certain observed facts, and was to be tested by whether the mathematical deductions to be drawn from it accorded with experimental data. An hypothesis was regarded by him in the same way, its value depended on how far it fitted in with what was known, and on its suggestiveness as to future results. Many

hypotheses might prove most valuable, though eventually they might be discarded as untenable in the light of further knowledge, because in their lifetime they had rightly directed research, or proved of convenience in co-ordinating apparently disconnected facts. They were simply a larval protection discarded when a more advanced stage of life was reached.

Very soon after Lord Moulton came to London he commenced working with Mr. William Spottiswoode on the researches which finally won him the Fellowship of the Royal Society. These investigations were of a purely scientific character, and were largely directed to the elucidation of the nature of positive and negative electricity. In the more commonly occurring electrical phenomena, such as the effect produced by a current passing through a wire or a chemical solution, little difference appears in their effects except that one is the opposite to the other. In fact for long equal importance was attached to two theories, one of which, the "two-fluid" theory, asserted that there were two essentially different kinds of electricity, while the other, the "one-fluid" theory, looked on a negative charge as simply indicating the absence of positive electricity or *vice versâ*.

The investigators therefore sought for phenomena where Nature showed herself in a more communicative mood, and they chose the time when a current was passed through an exhausted tube. As the resistance between the terminals of such a tube is very great, means for producing a great difference between the

electrical pressures at the two ends must be employed, and for this purpose an "induction" machine is used which produces an enormous difference in this pressure or "potential," but passes so little current that experiments can be conducted with safety. If in addition an air gap is introduced into the circuit, the discharge takes place in a series of jumps, for the balls on either side of the air gap become charged till their difference of potential is sufficient to produce a minute spark across the gap, which sends a current through the tube, and at the same time equalises the potential of the two balls, till the induction machine causes it to rise again. If the spark-gap is so adjusted that these jumps occur many times in a second, the discharge through the tube assumes the "sensitive" state, so called because the approach of any conductor causes an immediate change in the column of light which marks the path of the discharge. If, for example, the finger is placed against the tube, the electricity of a particular sign which is at the moment opposite to that spot in the tube calls up from the earth to the finger tip electricity of the opposite sign, so producing "relief" of the tension in the tube, with a consequent change in the appearance of the column.

By these means they were able to demonstrate the essential conditions for the sensitive discharge, viz. that each discharge must consist of a quantity of electricity great enough to produce changes of electrical tension in the tube which would render the

relief and corresponding phenomena perceptible, and also showed that in all probability the "continuous" discharge was of the same nature as the "sensitive" discharge, but that the individual discharges which made it up followed each other so rapidly, that firstly the discontinuity could not be detected by any means then known, and that secondly the quantity of each discharge was so small that "relief" effects could not be detected.

The results obtained could therefore be generalised so as to apply to all discharges through vacuum tubes, and probably also to discharges through air. The chief of these results was the demonstration that when a discharge through a tube is caused by an air-spark placed between the positive pole of the induction machine and the tube, what leaves the positive terminal in the tube is really a pulse of positive electricity which is shot out from that terminal, and gradually spreads out as it moves, like a pair of lazy-tongs, so that although it progresses generally in the direction of the negative terminal, its start is almost independent of the circumstances there, while the discharge from the other terminal is like a continuous leak of negative electricity which proceeds, not only during the period of the positive discharge, but also in the intervals between discharges. Similar results were obtained when the air-spark was between the negative pole of the induction machine and the vacuum tube, though the phenomena produced were quite different; in fact,

much of the importance of the researches depended on the differences found between the manifestations accompanying a positive and a negative pulse. These results obviously lend strong support to the view that positive and negative electricity have essentially different qualities, i.e. to the "two-fluid" theory, although the investigators themselves cautiously refused to commit themselves to any definite pronouncement on this point.

The experiments also showed that the discharge through a vacuum tube is often not by a single jump, but that it proceeds by a series of steps between the "striæ" or bands of light so often observed, and that each of these "striæ" is like a complete tube with positive and negative terminals, etc. The authors compare the method of these discharges to boys passing a stream on stepping-stones, each following his predecessor as the latter's foot moved forward.

The results also established important facts as to the comparative times of the actual discharge of electricity from a terminal, the time taken by the electricity in passing along the tube, the corresponding time taken in passing along a wire, etc. etc., and also as to the true meaning of phosphorescence in high-vacuo tubes, and as to the phenomena attending the discharge of electrons from the negative poles.¹

¹ One method adopted was so pretty scientifically that it merits record. The experimenters wished to extend their researches to tubes with different degrees of vacuum and containing different gases. The difficulty was that the optical manifestation of the results varied in each of these tubes, so that apparently each would demand a complete

These researches, though of no immediate commercial importance, formed an essential step towards our present knowledge of the nature of the electrical discharge, and to some extent of electricity itself, and their great importance has been recognised by so high an authority as Sir J. J. Thomson.

These researches procured for Lord Moulton the Fellowship of the Royal Society, a distinction of which he was justly very proud, since he was the first practising member of the Bar to be elected to this Society, and for very many years the only one, till he was joined by his friend and fellow K.C., Mr. W. R. Bousfield. He was very anxious to continue these researches, and made many attempts to do so, but the pressure of his professional and other work proved too great, and he was finally compelled reluctantly to abandon the quest.

But probably Lord Moulton's greatest gifts to

separate course of study. But they called to aid their theory of the "relief" effects, viz. that the pulse, say of positive electricity, passing through the tube obtained "relief" by calling up negative electricity to a piece of tin-foil placed on the tube. If now a wire were led from this tin-foil to another piece of tin-foil placed on a second tube through which a discharge was also passing and which they named the "standard tube," as negative electricity came up to produce "relief" in the first tube, the second piece of tin-foil, from which this electricity had been drawn, would acquire a positive charge and therefore produce effects on the discharge passing through the "standard" tube which could be detected. The reason for the name "standard tube" now becomes clear, since the experimenters when they tried a new tube had no longer to attempt to examine phenomena in an unknown terrain, but could judge the nature and quantum of the tension changes in the new tube by their optical manifestations in the standard tube, with which they were so well acquainted.

science lay in another direction—in stimulating and directing the work of others. He had an almost unequalled power, not only of expounding any scientific subject with astounding clearness and simplicity, but of illuminating it with some pithy sentence which, light as it may seem to the casual reader, might well influence the whole work of those who heard.¹ Much of this influence has escaped, and will escape, recognition, even by those on whom it was exerted. The very aptness of such expressions causes them to become current, and to seem such a natural and common expression of the subject that their inventor is soon forgotten. Nor can I give any adequate account of such work here. The happy phrase in which he could so well embody some deep scientific truth, and which brought to his hearers' minds a conception of that truth full of vitality and suggestion, loses much if not all of its fragrance and spontaneity if it has to be preceded by a laboured description of the subject he was treating, and of the ideas he wished to express. But certain of his addresses are so worthy of preservation that I give some extracts which I trust will convey his meaning.

In 1909 Lord Moulton was paid the great compliment of being invited to give the opening address to the Faculty of Medicine of the Leeds University at the commencement of their session. It was of course

¹ Sir Almroth Wright, one of his most intimate friends and co-workers, has described him as having "a magnificent power of generalisation."

an exceedingly difficult task for a layman to address medical men of the highest standing on their own subject, but many of the most eminent members of the profession have declared that his address was the best exposition ever made of the theme he chose—how the body resists microbic invasion and how that resistance can be increased.

For the purpose of this address he likened the body to a besieged city which is surrounded for the most part by an efficient wall—the skin—but which is liable to invasion either through accidental breaches in this wall or through the avenues which must be left open for the access of the necessary supplies of food and oxygen. Such an invasion must be met by resistance organised in the city itself. But the resistance exhibits the paradoxical quality that its efficiency increases as the strength of the body diminishes. To illustrate this he described the course of a fever :

“ The original infection is minute, and the body into which it is conveyed is healthy, yet the microbe increases beyond all power of calculation, and assailing the vital functions of the body brings the patient to the verge of the grave. At that moment when his strength is at its lowest, when his vital powers are well-nigh exhausted, when probably each microbe of the originally infected matter is represented by countless millions of equally virulent microbes as capable of infecting a healthy man as were the original invaders—at the moment, in short, when the invaders’ strength is so high and that of the organism

is so low, the tide of battle turns and the enfeebled body repels an enemy immeasurably more strong than that which the healthy body fails to keep in check. Some righting force, some powerful influence tending to bring back the organism to its normal state must have been developed during and by the sickness which makes the sick man triumph where the healthy man could not resist. Like to a ship in a storm the 'righting couple' which draws it back springs from the danger itself and proves itself to be the strongest when the storm apparently is doing its worst."

Then he showed how bit by bit experiment and observation have proved that this newly given power of defence was bound up with changes in the blood serum, specifically directed against the particular danger to be met. In the case of bacteria which multiply slowly and whose special danger is the poison they produce, a mere antidote to the poison may be evolved; in the case of others the blood may develop products which kill or cripple the invaders; but the commonest method of all is one which can only be described in the language of the gourmet, for the blood seems to supply a sauce which renders the particular microbe far more palatable to the white corpuscles—the scavengers—so that each absorb many more of these enemies than before.¹

¹ This idea is preserved in the phrase "opsonic index" (derived from the Greek ὄψον, a condiment or sauce), which expresses the average number of microbes devoured by each white corpuscle in the blood of a patient compared to the corresponding number devoured by the white corpuscle in normal blood.

But in each case the counter-body is harmful only to the particular enemy. "Nature, like a skilled boxer, hits straight back at its assailant and at him alone." So much is this the case that an early diagnosis of, say, typhoid fever can be made by testing whether the patient's blood has become specially fatal to typhoid bacteria. Lord Moulton then dealt with the rationale of the methods of assisting the defence. If Nature is merely preparing an antidote to the poison, supplies of this antidote can be hurried up from outside—by the injection of serum as is done in cases of diphtheria. But if the blood has to develop the power of destroying the enemies themselves, this development can generally be increased or accelerated by the introduction of fresh bacteria, or rather of their dead bodies, which are equally effectual, for "Nature recognises her minute foes by the taste of their flesh." This method of vaccine treatment may be applied beforehand—prophylactic treatment—or during the course of the disease—phylactic treatment.

The former is comparatively easy to understand, but in the case of the latter there comes this puzzling question: Why when the course of the disease has produced so many living microbes should there be any need of introducing others—and merely dead ones—to stimulate the blood to action? Lord Moulton's answer was that Nature does not run the risk of admitting the live invaders to the open bloodstream if it can be avoided. Her first method of

defence is the barricade—represented by the inflammation which so often cuts off an affected part, such as a boil, so that the blood-stream hardly penetrates there ; it does not infect the invaders nor is it affected by them. “ The focus of infection constitutes a sort of Alsatia which the police leave unraided so long as its inhabitants keep within its borders.” But in the case of an inoculation the dead bacteria are introduced either into the blood-stream itself or into tissue which is healthy and which, since the microbes are dead, remains healthy, and under these circumstances antibodies can be freely developed in the blood. The result is thus described :

“ When the inoculation has succeeded in raising the avidity of the white blood corpuscles it is easy to see what happens at a focus of infection. The sulky and ill-kept truce is no longer observed. The corpuscles are able successfully to penetrate further across the boundary because they can dispose of so many more of the defenders. Gradually the ground is cleared and the focus diminishes in size, and if the reaction to the inoculation be adequate and sufficiently long sustained the infection wholly disappears.”

Lord Moulton then commented on the impracticability of adopting the prophylactic method except for some of the commonest diseases, as the protection against each disease necessitates a separate inoculation, and prophesied that the future progress of medicine lay largely in the phylactic or curative use

of vaccine. He concluded by emphasising that these were Nature's own methods :

“ In all this we are adopting Nature's means in order to outdo her work. For you . . . must never forget that you have set yourself a harder task than that with which Nature contents herself. The sacredness of human life in our eyes compels us to keep alive those that Nature would let die—to produce health where she would accept disease—to make life possible under circumstances where she would abandon the attempt. She is satisfied if the efficacy of her defence would save enough. We seek to save all. But though you seek thus to outdo Nature, you cannot effect that object better than by wisely supplementing according to individual need that which is done automatically by Nature in racial self-defence. In so doing you will be a useful ally to Nature and fit to fight by her side, for you will have learnt to follow her tactics.”¹

On the occasion of his election as President of the Institution of Junior Engineers Lord Moulton spoke

¹ Lord Moulton also emphasised this point in his evidence before the Commission on Experiments on Animals, where, referring to some previous evidence, he said : “ I was much amused by some evidence given by one of the lady witnesses who have given evidence before you. She seemed to be very much disgusted with the consequences of all this knowledge of inoculation and vaccine, and, if I might paraphrase, what she said was : ‘ Nature has made such nice drugs and put them in plants all around us. Why should we not use these and not go to such messy things as serum.’ These are not her words, but they express the effect of them. Nature has put all kinds of useful drugs in plants, but she never dreams of using them for curative purposes. Her method of curing is entirely by means of the messy things with which the researches of the last forty years have led us to work.”

on the subject of invention. This address is of special interest, as it is all that he has left on the subject to which he devoted so much of his life. The ordinary man regards invention as a haphazard process, usually the result of some chance idea, and very little attention has been paid to the psychology of the subject. But Lord Moulton showed that this was far from being the case, and sketched out the principles by which successful advance may be made. He dealt more particularly with the large class of machines which seek to replace manual operation by the use of mechanism, and showed how success is obtained, not by a servile imitation of the human motions generally employed, but by finding an equivalent cycle of operations more suitable for mechanical reproduction :

“ Let me take an analogy. Doubtless you have often had to send a message by telegraph to some distant country to which the rate charged per word is high. You write your message as tersely as possible, but even thus its length is formidable. What do you do ? You fly to your telegraphic code. It tells you that if you will change the phraseology of your message you can, by a single code word, represent a whole phrase. You thereupon set to work to recast your message so as to make it capable of being expressed in code words. When you have done so you have not improved it as a message. It is less terse and less naturally expressed. If you were writing and not telegraphing you would prefer to use it in its original form. But as now expressed

each of the phrases of which it is composed can be sent over the wires in the form and at the price of a single word, and the cost of the whole is but a fraction of what would have been the cost of your message as originally framed. It has been recast in a form suitable for cheap telegraphing.

“Just so the inventor. He has to find a series of operations which in their totality are equivalent to the series of the hand worker. But each of these operations in itself need not be such as would in hand labour be suitable or even practicable. It is necessary and sufficient for him that they are suited to the new conditions, i.e. that they can be well and easily done by mechanism, and that, taken as a whole, they produce the same result as the series which he is paralleling. He is rewriting the series in terms suited to mechanism just as the message was rewritten in terms suited for telegraphing. The meaning of the message must remain the same, but the terms used to express it are no longer those most naturally used in writing or speaking, but are those which can be telegraphed at least cost.”

He illustrated this by the history of the sewing machine. The earliest attempt to make such a machine followed closely the human actions. Pincers, representing the thumb and finger, passed the needle, which was pointed at both ends with the eye in the middle, through the fabric to a similar pair of pincers which moved the needle away to the full stretch of the thread, and then returned it through another hole. He then continued :

“ There is not much coding here. The new cycle imitates the hand worker so faithfully that it benefits little by the advantages of mechanical action. As in hand work, it can only sew with moderate lengths of thread, and must therefore have the needles re-threaded at intervals. Its superiority over hand labour is therefore so slight that it is doubtful whether such a sewing machine could ever have competed with, much less replaced, handwork. . . . What is the reason of the comparative failure of this attempt ? It is evident that it is due to the retention of the feature of the hand operation by which the needle is passed from one holding mechanism to the other. The inventors of the modern sewing machine, on the other hand, decided to work with a needle fixed in its holder and never leaving it throughout the operation.

“ It at once followed that the needle and thread must, on the back stroke, return through the same hole through which they entered the fabric, so that no stitch could be formed unless some obstacle were interposed to the return of the thread. Thus in the lock-stitch machine the substituted cycle became as follows :

“ (1) The work is moved under the needle for the new stroke.

“ (2) The needle (which has an eye at its point through which the thread passes) pierces the fabric, carrying with it the thread.

“ (3) A second thread is passed between the thread and the needle (by means of a shuttle or its equivalent) when the needle is at its lowest position.

“(4) The needle returns, while a ‘take up’ retracts the thread so as to tighten the stitch.

“This cycle would, for hand work, be immeasurably more complicated and difficult than ordinary sewing, but it consists of operations mechanically easy of performance in swift and accurately timed sequence, and as the whole of the thread in use has no longer to be passed from one side of the fabric to the other as each stitch is made, it has brought with it the all-important advantage of being able to work with a continuous thread. Here, then, is a magnificent example of ‘coding.’ It is not to be wondered at that machines which it has given to the world are in well-nigh universal use, and have profoundly modified both our social and our industrial economy.

“You see that I have hardly touched on the actual mechanism to be used for performing the several operations of the coded cycle, and it is not necessary. In such a case as this the invention practically lies in performing the operation of ‘coding’ aright. It is this that explains what you so often see in the history of an invention, viz. that everything appears to come from the adoption of one special element which thereafter forms a part of all machines for the same purpose. Thus it is sometimes said that the invention of the sewing machine consisted in putting the eye of a needle at its point. In a very real sense that is the fact. Such a needle indicates and embodies the fundamental changes of the cycle in which the real invention consists, and the adoption of such a form of needle implies the adoption of this new cycle.”

The importance of this analysis of the essentials of

success in one of the widest fields of invention would justify its preservation, apart from the fact that it is a typical example of Lord Moulton's powers of description and explanation at their best.

Lord Moulton then gave another example of a cycle of a very different nature—that by which metals are gradually shaped by a series of pressures—as for example in drawing cartridge cases. Of these he said :

“ There are cases in which the whole invention may be said to consist in the choice of a cycle. Take for example the process of shaping metals by pressure. The whole success of the process in its application to the more complicated forms depends on the judicious choice of the series of intermediate forms through which the metal is made to pass. You are dealing with substances so resistant that all attempts at sudden or violent transference of material from one conformation to another must result in weakening or rupture. The series must, therefore, be such that each step entails a transference under suitable and advantageous conditions. It must leave the material in the position best suited for the next step, as a good billiard player takes care that the balls shall be left so as to make his next stroke an easy one. To design successfully such a process may involve invention of a high order, even though the execution makes use only of ordinary tools.”

In another part of his address he deplored that so many inventors never completed an invention, but

were always changing to some fresh idea, so that they never achieved a commercially useful result.

“ ‘ Have something to say, say it, and sit down ’ was the reply given by a Parliamentary veteran to a new member who asked for advice as to how to speak. How often have I wished that inventors would take this counsel to heart in all its fullness. They often have something to say, and they say it, but they will not then sit down. . . . They are never content to work out practically what they have invented. Fresh inventions are their remedy for every difficulty, even for such as naturally occur in all industrial developments, and thus perpetual change leads to delay, loss, and final abandonment. ‘ *Le mieux est l’ennemi du bien.* ’ ”

He told how Babbage, one of the most brilliant inventors of the last century, spent a long life on his calculating machines, and left nothing—not because his plans were impracticable, but because before ever a machine was finished a new and better idea had displaced it in his fancy. So great was his reputation that after his death a commission was appointed to examine his models and papers to ascertain whether the Government would be justified in completing his work at the public expense, but the report was that nothing had been carried to the point where success could be predicted.

For such inventors Lord Moulton had little sympathy.

“ I confess that in my secret heart I consider them an almost unmitigated nuisance. They accomplish nothing themselves and they detract from the merit of those who by greater perseverance and more patient labour have succeeded where they have failed. Their inventions attain posthumously a short-lived forensic glory by being paraded as anticipations of some later invention which has proved itself to be worth defending.”

It is of course not possible to teach everyone to invent, but this address undoubtedly contained much that will assist potential inventors to economise their efforts and direct them on the lines leading to practical success. Lord Moulton laid special stress on the advantage of inventors having a thorough knowledge of what their predecessors have done, with the double object of avoiding waste of energy in reinventing what is old, and of being able to select the most appropriate means for carrying their own ideas into effect. But quite apart from this direct use Lord Moulton urged the study of great inventions for educational purposes :

“ I want you to look on famous inventions as a scholar looks on the works of our great authors. He reads them not only to enrich his vocabulary, but to teach himself consciously and unconsciously how words can best be used. You cannot read an essay of Macaulay without learning something more of the power of our language. So it is with the machines of the great inventors. They are your literature. You cannot master their construction without getting

a firmer hold of the resources of mechanical science. My advice to you is, ' Master your machines.' "

Turning to the legal aspect of invention, he praised the spirit of the British courts in judging the existence of invention rather by practical usefulness than by such barren academic standards as " the novel technical effect " beloved of the German Patent Office. He expressed his own opinion that improvements which led to a better or cheaper process for producing an old result were often practically of greater importance, and might be more worthy of reward, than many new processes. " Inventions " are defined in our law as " new manufactures," and Lord Moulton's view was that they should merit this name.

" I have long contended, and I think it is now settled law in our courts, that an invention is not made until it has been developed so far that the normal result of its working is success. Uncertainty in result beyond this point means practical uselessness, and as it in fact leaves the field still unoccupied for future inventors, so it should do in law, and their fame and their reward should not be lessened by the useless half-successes that have preceded them."

Lord Moulton admitted that the inventor alone could not in general achieve commercial success, and he regretted that in the later stage where financiers and business men must carry on his task England compared unfavourably with Germany and the

States. Here, as on many other occasions, he expressed his conviction that in scientific and inventive ability we were quite equal to any of our rivals. But, in general, though there are many honourable exceptions, the "business man" in this country expects too much from the inventor. Some may think an invention promising, but object, rather irrationally, that the new process has not yet proved its value; others reject it for minor technical difficulties or because in its original form it is not a complete success. Both courses may be very unfair to the inventor. Not all new processes "spring fully armed from the head of Zeus," and many of the most successful inventions have needed years of trial and tens or hundreds of thousands in expenditure before reaching their final form. Even if the inventor has the means, he is often not the most suitable director at this stage. If he has given an idea and shown how it can be practically turned to account, he has achieved success from the standpoint of invention; the choice of the very best means for carrying out this idea may well be left, in many cases, to persons of riper experience and wider knowledge. For this reason Lord Moulton rather deplored that so many companies were formed to exploit individual inventions, since the management so often comes into the hands of the inventor himself, who has usually little commercial training.

Lord Moulton was a strong advocate of the importance of exploratory research directed rather to

acquiring exact knowledge of natural phenomena than to achieving some new end. One of his expressions was: "It is a bad thing to work too directly and too consciously for practical results." He illustrated this by the history of alchemy:

"For centuries men of the highest intellectual attainments—for there can be no doubt of the ability of the men who worked at these subjects—worked hard at the transmutation of metals, and the result of those centuries has only been snippets of knowledge, if I may use such a phrase. I do not understand them. They gave us, I believe, some very valuable reagents, but that is practically all. And the reason was that they did not commence by working so as to get to know the nature and properties of the things on which they were working, they worked straight for a result. It may have been an impossible one. But whether it was impossible or possible would have made very little difference if they had commenced by laying the foundation in knowledge, because although we should not have obtained the transmutation of metals we should have had modern chemistry some three centuries earlier than we did. . . . But if they had only laid a basis, if they had only worked at it as you try to reduce a fortress, by parallels, where each parallel brings you nearer the fortress. If you attempt to take it by a rush and fail, you are no further than you were before, but if you make your parallels, you are so much nearer, and that is a permanent advance."

In his view the progress of human power over

Nature was achieved by workers of three different classes. The scientific investigator referred to above might not achieve any practical result, but he consolidated the ground and made a firm "jumping-off place" for further progress. The actual inventor might be such a scientific investigator, but he was often a man of quite a different type. Meticulous accuracy and a strictly logical mind were essential to the investigator; the inventor often benefited by the lack of these qualities. A somewhat loose mind—one that jumped at results which could not be certainly predicted—often marked the successful inventor, the man who advanced boldly, where his more scientific brother might quite rightly say that the ground should be carefully tested before each step. Kipling observes that if the British Army had always waited for reserves when they ought to the Empire would have stopped at Hastings beach. So also scientific progress owes much to those who have refused to wait.

To continue Lord Moulton's simile of the attack on the fortress: the investigator advances the trenches, and the inventor is often the man who springs from the trenches to rush the fort. If he fails, he has achieved nothing, and is unheard of; if he succeeds, this success has been rendered possible by the painstaking efforts of the scientific sapper.

So he traced the work of the investigator and the inventor—work involving ceaseless expenditure of energy—energy usually producing a quite incom-

mensurate output. Then he turned to the third class—the technologist. In one of his addresses he takes an illustration from Milton's *Paradise Lost*.

“The great poet describes Satan as toiling through the vast void to reach our earth and he says :

“ ‘ So he with difficulty and labour hard,
Moved on—with difficulty and labour he.’

Then he describes how once he had passed through the wide expanse, his two companions (Sin and Death) :

“ ‘ Following his track—such was the will of Heaven,
Paved after him a broad and beaten way
Over the dark abyss.’

Nothing could better express the contrast between the work of the scientific discoverer and the technical giants who followed him. The one as a pioneer finds his way with doubt and difficulty through the unknown, till he unravels the mystery and reveals the truth that he has been seeking, and that is his triumph. But the triumph of the others is the broad and beaten way that they make afterwards, after the truth has been arrived at, so that all can avail themselves of its results.”

It was to this last class that he especially addressed himself on many occasions. Both before and during the war his experience taught him that it was in this branch—especially in the realm of chemistry—that there was the greatest danger of our foreign rivals outdistancing us. In an address delivered shortly after the Armistice he said :

“ I doubt whether at the time the war broke out we had any fear, or reason to fear, that our foes possessed chemical knowledge that was hidden from us. It was not the lack of chemical knowledge that gave us so many anxious hours, but it was the fact that in Germany the results of chemical research had been widely applied in practice, that their Chemical Engineers had learnt their business, that they had put up the plant that was necessary for production, so that in short as far as was then possible the results of chemistry in Germany did not rest in the form of knowledge only, but had become knowledge applied in practice. As the war went on, and we by the pressure of our Fleet reduced our foes to greater and greater straits in the way of obtaining materials necessary for Military and even Civil use, it was this practical acquaintance with Chemical Engineering which enabled them again and again to find and use substitutes for materials rendered inaccessible to them by our blockade, and which in times of peace would have been regarded as essential to their manufactures.”

Though the passage quoted dates from after the war, Lord Moulton had incessantly urged during the last twenty years the importance of the greater development amongst us of this science of chemical engineering.

I think he considered himself as doing missionary work in this connection to break up that ignorance on the subject which was so prevalent. The public could understand the need for chemical research,

and the difficulty of such research ; but not only the public, but many engaged in commerce and manufacture failed to realise the true nature of the gulf which yawns between success in the laboratory and commercially profitable production, and Lord Moulton sought to bring home to them what the most important differences are. The first difference is in the scale. There is a great tendency to underestimate the difficulties connected with this.

“ Change of scale is a matter which is infinitely more important than people imagine. It seems so easy to allow for it. It seems to make little difference whether one works with bigger plant and deals with bigger amounts or deals with the same substances and the same plant on a smaller scale ; and just because it seems to make so little difference, change of scale is more likely to lead clever men into trouble than almost any single change of condition which one can specify.”

Lord Moulton often illustrated how this change may lead to disaster by the example of the ill-starred *Great Eastern*, built in the sixties by Scott Russell, the most eminent naval architect of his day, and double the size of any previous ship. It proved an utter failure because, skilful as he was, he had not the knowledge as to what were the modifications in structure necessary for this big change in scale. So useless was she that she was beached and left to rot. And yet the problem was perfectly solvable, and

gradual increases have since resulted in ships far bigger than the *Great Eastern*.

It is this change that the chemical engineer must be competent to effect, a feat which demands the most thorough knowledge both of chemistry and engineering. But this represents only one part of his problem. In the laboratory time is of no account, the purest chemicals are available, the expenditure of energy in such processes as heating or mixing negligible. But the technical chemist who follows has to reach the same result in a sphere where cheapness is the consideration that rules throughout. However interesting a process may be scientifically, it cannot hope to attain industrial life unless the technical chemist can so adapt it that it can compete with other processes in this capital respect.¹

Lord Moulton never wearied in preaching the importance of cheapness, since he regarded it as the general measure of the total human effort used in producing a result. The man who showed how the same article could be produced more cheaply was, in his opinion, the world's benefactor, since he showed how to save human effort, and so rendered more of this available for producing something else which would add to the happiness of mankind.

One of the most valuable of Lord Moulton's contributions to the cause of humanity and science,

¹ Unless some accidental circumstance intervenes, such as the value of a by-product, or the possibility of utilising a comparatively useless by-product of another process.

and perhaps the one he would have least liked to drop into oblivion, was his defence of medical research and those engaged therein. It is one of the unfortunate facts of life that those most intimately concerned in research so often lack either the time or the mental equipment for explaining their work to the public ; it is doubly unfortunate in the case of those whose efforts are directed to combating disease and pain, since by a strange instance of fate's humour they are exposed to the venomous attacks of persons styling themselves humanitarians.

Many a time did Lord Moulton offer yeoman service in protecting those who were engaged in this war on pain, but the principal occasion was when he gave evidence before the Royal Commission appointed in 1907 to consider the question of experiments on animals. As this evidence is probably the clearest and most logical statement of the case for scientific research, I shall give a short *résumé* of the more important parts.

Lord Moulton first explained to the Commissioners that one of his chief reasons for the study of the subject had been the feeling " that the need would come for interpreters between those who are carrying on research work and the public in order to explain and justify their work." The real question at issue was whether or not curative science should be studied experimentally or whether the workers in this branch should be handicapped—as compared with all other scientific workers—by being confined to observation

only. In every other field of research rapid advance depended on experiment,¹ which is observation under the exact conditions necessary for the solution of the problem at issue. As long as you can merely observe, progress is very slow.

“The reason is that experiment is like cross-examination; you can put the question you want and Nature always answers it. She does not answer the question you meant to put, she answers the question you did put. She swears by the card in the most shocking manner. She does not care in the least what you meant to ask, but she does care what you asked, and she answers it with perfect truthfulness. And the consequence is that when you adopt experiment, the great experimenter can put a question the answer to which lets the whole secret out.”

Lord Moulton gave several examples of how a single experiment could replace decades or centuries of mere observation. One instance was that test which decided the question whether tuberculosis was communicable or whether it only came as the result of inheritance. If it had been left to the practitioner to determine this by observation, no solution might ever have been reached. It would be extremely difficult to find a family with no history of tubercle, and the laws of heredity are largely *terra incognita*. But a dozen guinea-pigs were taken and six put for

¹ Lord Moulton could only think of one branch of science which had depended on observation only, experiment being impossible, viz. the study of volcanoes—and here, he pointed out, our knowledge had hardly progressed beyond that of the ancient world.

a time in a consumption hospital, six under identical conditions in another hospital where there were no tubercle patients. The question had been properly framed, and Nature gave the true answer. The six in the consumption hospital had developed tubercle, the others had not. Tubercle was therefore for the first time certainly known to be communicable, and the whole modern system of dealing with it is based on that fact.

It is the power of choosing the conditions so that they are identical except for the factor to be tested which gives experiment its immense importance. This method is clearly inapplicable in clinical practice, since here the doctor's one duty is to do the best for his patient ; he cannot, for example, delay treatment so that the disease arrives at the same point of aggravation as in some other case which he had previously treated, in order to test whether a new drug or serum would cure where without it he had failed. Lord Moulton's evidence traced how by experiment we had learned to some degree to fight microbic disease by Nature's own methods, viz. by strengthening the resisting function of the blood and lymph rather than by the artificial methods of drug administration.

Turning to the ethical side of the question, he defined the difference between the anti-vivisectionists and himself as that they thought only of inflicted pain, while to himself the permission of preventable pain was just as bad as its infliction.

“ I want to put before you . . . the criterion which I say every humane man ought to follow. It is that he ought to take that line which before his conscience he thinks will lead to the diminution of total pain, and if he is satisfied that the infliction of a certain amount of pain is the right way to diminish the total pain, he is bound, from his very feelings of humanity, to take it.”

Tolerance was one of Lord Moulton's characteristic qualities, but it had its limits, and he could not prevent himself from speaking plainly of the stupidity and hypocrisy of those who were trying, on the score of the possible sufferings of the animals who were the subjects of experiments, to block the path of medical progress.

“ I read through the list of experiments which were thus done in a year, and I very much doubt whether the total amount of suffering caused by those experiments would be much greater than would be caused in a single fairly large shooting party in which there were one or two bad shots. If you consider the amount of suffering that is caused in the world, not only thoughtlessly, but even deliberately done by people who are ordinary normal men and may be able to show a reasonable defence for what they do, it dwarfs so utterly the amount which is requisite to produce this useful knowledge, that if the matter were not so serious it would be almost ludicrous to think that there was this organised opposition to the pain caused in scientific research in proper hands. Why, what is attacked here is the

only bit of fruitful pain in the world. The greater part of pain had better not be. A man suffers and dies, or suffers and gets well, and all the pain he has suffered has benefited nobody. And in the case of animals there is all this vastness of pain which is inflicted and permitted, and people tolerate it and say nothing about it, and look on it as an ordinary thing, but there is one little bit which brings return in lessening the sufferings of the world, and people are to be found to organise themselves against it and throw the whole of their strength into denouncing and preventing it."

Lord Moulton pointed out how much of the strength of his opponents' case lay in their choice of words suitable for misinterpretation by the public to whom they appealed. One of these was the continual suggestion of animals being sacrificed for "experiment," a word which to the non-scientific bears a savour of chance and doubtful gain, whilst the scientist knows that in every branch experiments are the milestones of progress. Lord Moulton pointed out that these animals were sacrificed not for the sake of "experiments," but for the certain progress that flows from them. A flowery passage from some anti-scientific writer was put to him, where the author speaking of a certain medical investigator asks: "Who gave this amazing enthusiast the right to say off-hand that he was at liberty to exploit the lower animals for experiments?" Lord Moulton's reply was: "Supposing I was to put, instead of 'experi-

ments,' 'saving life,' or 'stopping human suffering,' the whole appeal falls to the ground."

Lord Moulton's evidence is well worth reading in full, not only for its bearing on the particular subject, but for its relentless logic and clearness of exposition. It would, I think, be difficult for anyone so reading it to doubt that he has established that experiments on living animals have led to much of our medical progress in the last half-century, and are absolutely necessary for such progress in the future. His treatment of the ethical side reflects his tendency to look at totals, and not to be unduly affected by special items. The thought of suffering was hateful to him—but the suffering which he wished to diminish was the total of the human and animal world, and he would not be deflected from this purpose because some items of it would be classed as "inflicted," if this infliction diminished the sum total.

In 1912 Lord Moulton was named as the first Chairman of the Medical Research Council appointed to administer the fund of £50,000 per annum allocated by the Insurance Act of 1911 to the furtherance of medical research. The Council as originally constituted consisted of forty members, but as such a body would have been too unwieldy for the effective transaction of business, executive powers were at once vested in a committee of nine—six medical and three laymen—of which Lord Moulton was also chairman.

In this position he laid out the general programme which has since yielded such successful results. By

this programme the money at the Council's disposal was partly devoted to a central Institute founded by them at Mount Vernon and partly applied in grants for independent research throughout the country.

The field of research covered all classes of disease except cancer, which it was felt was adequately dealt with by the work of the Lister Institute, but the study of tuberculosis was marked out as one of the chief aims, not only from its intrinsic importance, but also because the study of this disease had been named at the time of the passing of the Act as one of the chief objects which induced the Government to make the grant. But Lord Moulton felt that the attack on this disease would be most effectively carried out by the indirect method which he had so often advocated for the solution of other problems, and the Council started, and have carried on continuously, a series of researches into the effect of such matters as heredity, food, occupation, ventilation, etc., as predisposing causes towards this, and incidentally other diseases, and are gradually accumulating a store of knowledge which must in time yield much valuable fruit.

The outbreak of war, following so quickly on the appointment of the Research Council, diverted their attention to fresh problems, connected with the treatment of wounds and the prevention of those diseases caused by the aggregation of troops or the conditions to which they were exposed during hostilities. Specially successful results were obtained with regard to the troubles caused by anærobic bacteria in wounds,

and the terrible attacks of gangrene. The latter question was a very complicated one, and could never have been solved by empirical methods, since it was ultimately found that about ten different bacteria co-operated in causing the forms of gangrene that occurred. Finally a serum was prepared which led to the most successful results. There can be no doubt that these systematic researches put us far ahead of the Germans in our treatment of these gangrenous wounds.

Thanks to the work of Sir Almroth Wright during and since the South African War the main vaccine was ready which was to ward off, for the first time in the history of war, that terrible scourge of armies, typhoid fever, but further protection was elaborated against the milder but unpleasant forms of it known as paratyphoid. Other diseases which were dealt with were dysentery, trench fever, and the meningitis—or “spotted fever”—which threatened to become such a danger during the time that our troops were crowded together in training camps. Another war trouble, and one which affected Lord Moulton very closely, was the poisoning that occurred amongst the workers in the T.N.T. factories, and here too successful remedies were found.

General researches were also initiated on the question of dietary and such matters as the rôle played by vitamines, the preservation of milk from contamination, etc. etc.

In 1916 Lord Moulton was reluctantly compelled

to resign his position at the head of the Council, chiefly owing to the great pressure of his work at the Explosives Department, but he had the satisfaction of knowing that he had launched that body on the course it has so successfully pursued.

In 1883 Lord Moulton was appointed a member of the Commission assembled at Paris for deciding on the units to be employed for the measurement of electrical quantities—a position for which he was doubly suited by his knowledge of electrical matters and his mastery of French. There he lent strong support to the course finally followed, viz. the adoption of an international system of units, so that electricity started on its commercial course free from the differences of national measures which are such a handicap in other branches. His services on this Commission procured him the Legion of Honour,¹ and he also became acquainted there with most of the Continental experts in electrical matters.

About the same time he was also appointed a member of the jury for adjudicating on the electrical exhibits at the Paris Exhibition. He was greatly amused by one of the incidents of this adjudication. Being young and energetic he suggested making tests of some of the apparatus exhibited, and was surprised to find that his older confrères would only agree to

¹ He was subsequently advanced to the grades of "officier" and "commandeur." At the end of the war the French Government expressed their desire to make him a "Grand Officier," but permission was not granted by the British Authorities for the acceptance of this honour.

this on the understanding that any tests so made should not affect the awards. He understood this better when tests of a beautifully-got-up piece of apparatus disclosed the fact that it had nothing in it at all. Some of the more experienced jurymen were not in the least surprised at this, and said that it was quite natural for a firm not to wish to expose delicate apparatus to the risks of an Exhibition, and proceeded to give the firm in question one of the highest awards.

Subsequently Lord Moulton served in similar capacities on many other occasions, and was finally a member of the appeal jury at the White City Exhibition at Shepherds Bush in 1907.

Lord Moulton also received the exceptional honour of being made a member of the three great Institutes of Engineering, his election to the Institute of Civil Engineers only occurring a few weeks before his death.

CHAPTER VI

PRIVATE AND SOCIAL LIFE

IT is with considerable hesitation that I approach the subject of my father's more intimate life. My own views—inherited from him—are that even the most public-spirited slave has a right to his *peculium*, those few hours snatched from his work for others to which his master the public has no claim either then or later. My father had a repugnance, almost amounting to loathing, for the free and hearty way in which so many writers rend asunder the veil covering private life, and it was with greatest difficulty that he could be persuaded to read their works, however great the interest or literary merit might be.

A further difficulty is that what is really of interest in the private life, even of the most eminent, is their peculiarities, and, so far as I can judge, my father had few, if any, of these. Thoroughly normal, with a great capacity for enjoying all the good things of life, his pursuits in his hours of leisure lacked any trace of eccentricity, and a record would only be of value as showing how impossible it is for a healthy, active, and educated mind ever to be bored.

One special feature of his character was his great reticence and regard for any confidence imposed in him, and even in his own family he never referred to anything that had been said to him as to which there could be any desire of secrecy. Further, he kept no diary and hardly any letters, considering the fire the only trustworthy guardian of confidences, so that the records of his private life are very scanty.

In 1874, shortly after he had left Cambridge for London, he married my mother, the widow of the late R. W. Thomson of Edinburgh—the inventor of the pneumatic tyre. My father and mother were both keenly interested in literature, science, and art, and their circle included practically all the mid-Victorian leaders in these subjects, notably Swinburne, Browning, Oscar Wilde, Lord Kelvin, Spottiswoode, Lord Leighton, Frank Dicksee, and Tenniel, as well as many visitors of great interest from continental countries, since Mrs. Fletcher Moulton as well as her husband spoke French and German perfectly.¹

Unfortunately my father's habit of never keeping a diary or other record has hid much which would now be of the greatest interest about his friends of that period.

¹ Another faculty which she possessed was an extraordinary power for mental arithmetic. My father told me that once when she had been at some entertainment where some performer had mentally multiplied together two numbers of three figures each, she performed the same feat with two numbers of fifteen figures each. She also wrote under a pseudonym a very charming study of the life of the poor.

My father and mother at this time lived at 74, Onslow Gardens, but as the family (my mother had four children at the time of her second marriage) grew up, a larger home was sought, and my father acquired 57, Onslow Square, where he lived the remainder of his life. Unfortunately my mother never saw the new home, as she died in 1887 just at the time it was being redecorated for her reception. After his first wife's death his stepchildren lived with him till in 1901 he married the daughter of Major Davis.

Major Davis, who had served with the Federal Army during the War of Secession, and had played an active part in industrial developments in the United States, had taken British nationality, but lived largely in his beautiful villa, La Floridiana, at Naples. Apart from its beauty this villa is of interest as being the scene in which the last part of *David Harum* takes place. In fact the author spent the last months of his life under Major Davis's roof, and it was largely due to Mrs. Davis's persistent efforts in taking the manuscript from publisher to publisher that this famous work was ever printed.

The marriage was a rather complicated affair, since the parties were both foreigners to Italy and of different nationalities, and the bride and bridegroom spent a long morning driving round while ceremonies were performed in the presence of four different authorities before they considered that they were safely married.

Some little time after his second marriage a dispute

arose between Lord Moulton and his stepdaughters as to whether in accounting for their income received by him as trustee under their mother's will he was entitled to make any deduction for the costs of their maintenance while they were residing with him. Lord Moulton was successful in the first court, but unsuccessful in the Court of Appeal. An appeal to the House of Lords was prepared, but a settlement was arrived at.

My father's second wife died after a long illness in 1911. He had one son, the writer, by his first marriage, and one daughter, Sylvia, by his second marriage.

My father's interests were so general that he could hardly be said to have had a hobby. Literature, art, science, the drama, and music (to quote the "Savage" formula) all appealed to him in their turn, and he seemed equally happy in the pursuit of each one.

With interests so widespread, dullness was impossible; whatever his mood of the moment, there was some subject that must fit it. His library was regulated accordingly. If he were wearied of reading bacteriology, he could seek the fascinating if less practical knowledge of the *Golden Bough*, from which he might turn again to a monograph on the Flemish painters or the verses of Lord Neave or Owen Seaman. This library would probably have been classed by the serious as that of a dilettante, were it not that many of the works would have been meaningless to one who had not a thorough grasp of the very abstruse subjects treated.

But my father had a very real idea of the need of complete relaxation, and when he sought this in fiction he sought it thoroughly. His view was that fiction—at any rate if intended for the man with a full life—must please, and must relax. He steadily refused to read novels—however eminent the authors—which did not conform to these criteria. The “problem story”—or play—was generally anathema to him; he wanted a story where at any rate some of the characters were sympathetic. Particularly did he loathe those heroes and heroines whose difficulties were self-created, however skilfully or meticulously their characters might be portrayed.

But in this, as in all other matters, he had the real spirit of tolerance. He recognised that deep psychological studies might interest and benefit those who took their chief mental exercise in the form of reading fiction. But he could in general find no relaxation in such reading, and he therefore avoided it.

I say in general, because he made an exception for many of the older novels, which he knew well and read time after time, and also, curiously enough, for foreign fiction. He seemed to find a charm in such writers as Balzac and De Maupassant which made up for the sadness and drabness of many of their stories.

His early reading had given him a remarkable knowledge of the Bible and our chief English classics, but this did not prevent him from enjoying thoroughly modern humorous or exciting fiction. But his great

love to which he was always returning was Charles Dickens. He has himself described what Dickens meant to him :

“ Dickens has been to me not an intellectual, but almost a physical delight. There was a time in my life when I had to work very hard, and whenever I came home utterly exhausted, the only moral feeling left to me being a hope that I should not vent it on the people I found at home, I used, in order to defend them from the threatened calamity, to take up a volume of Dickens. Well, you may say, there was something intellectual. Not a bit of it. I did not read it as any decently intellectual man should. I treated it just like a boy who rarely gets an apple treats that apple when he has got it. I turned it round and round and took bites out of the places that were most juicy. I would take some little thumbnail sketch in the book and I would follow through all its pages every word that related to the character chosen, and in that way I would eat my apple until at last there was not even the core left.”

Asked to define the qualities which so attracted him to this author, his answer was that the chief one was Dickens's essential charity to all men.

“ When little children are at play, the wee creatures make blunders in knowledge and taste, and they show all the absurdities of the grown-ups and most of their faults, and yet you cannot be angry with them. There is something so comic in their imperfections, something very similar to what you see when puppies

hardly able to walk tumble over themselves. You have a kind of fondness and tenderness for the imperfection, an imperfection upon which you would be severe in grown-ups. Well, Dickens taught us to look at everybody in that light. His characters are full of imperfections, are full of inconsistencies, are full of defects, yet somehow or other the infinite sympathy of the man makes us look at them with a kind of amused sympathy. We never feel severe to them. Perhaps it is that, by his genius, he was able to make us feel inwardly that we had better not be too severe on them because we look very much like them ourselves. In this way he has contrived to show as boldly as any other writer all the defects of mankind, and yet we do not feel a trace of scorn or bitterness with regard to them. To a soft-hearted man like myself that must have been one of his earliest charms."

One of his great pleasures in holiday times was reading aloud. Perhaps his favourite author was Swinburne, to whose poems his readings seemed to add a new charm, but first to his wife and later to his daughter-in-law he read many of the French and English books he loved.

Mathematics was another of his holiday recreations. Although he never had time, after leaving Cambridge, for serious mathematical work, he was very fond of trying special problems, such as devising means for the rapid calculation of logarithms, and this new form of mental exercise provided a real rest.

Foreign languages and literature had a great attraction for him. He was continually extending the

excellent knowledge of French which he had got from his early conversations with his stepmother, and this knowledge often stood him in good stead, notably at the time of the International Electrical Congress in 1883 and later in his relations with the corresponding French Department during the war. I remember towards the end of 1916 M. Albert Thomas, the French Munitions Minister, and General Manclère, head of their Explosives Department, with some of their staff, dining at Onslow Square during a flying visit to London. Had the conversation been reported it would probably have equally astonished friend and foe. Munitions and the war were temporarily forgotten in a dispute as to the comparative merits of modern French authors, and I remember my father upholding, rather to the horror of his guests, the claims of Catulle Mendès on the grounds that the purity of his style and the power of his writing more than compensated for his unorthodox views on, and untrammelled treatment of, the subjects on which he wrote.

He had enjoyed no family advantage with regard to Germany, but owed his knowledge largely to the vacations he spent in Germany during the time of his Fellowship. On some of these he stayed with German families, and he used to tell of an attempt he made to describe to his hostess what an English Sunday was like in a Methodist family. He explained that no ordinary books were read, that walking for pleasure was discouraged, and talk on worldly matters frowned

on. "Ah then," was her reply, "you have nothing to do but play cards all day."

In the Long Vacation of 1870 he took a reading party to Saarbrücken, and was there when the war cloud broke. The position of England was of course absolutely neutral, but undoubtedly the Germans thought that the connections between the two courts would draw us to their side. This feeling enabled Englishmen, especially those who spoke German, to move freely in their lines, and my father got on very good terms with the German soldiers. He has often told me how he used to sit at night with the sentries on Saarbrücken Bridge wondering when the French would attack and commence that advance on Berlin which everyone expected.

This intimacy nearly had a tragic end, in fact he narrowly escaped being the first man shot in the 1870 war. He was in the habit of strolling in the neutral zone between the lines of sentries, and no objection was made to this. Coming back one evening he heard as he passed a sentry a guttural noise to which he paid no attention, but a few seconds afterwards a sharp click reached his ears, and he turned to find himself covered by a needlegun and the sentry just preparing to fire. The pickets had been changed while he was out, and the new sentries promptly put him under arrest. However, next morning a friend, a war correspondent with a pass under Bismarck's own hand, vouched for his neutrality and he was released.

His nearest approach to a hobby lay in the collection of what was beautiful. During the time when his first wife was alive they accumulated a very fine collection of Rhodian pottery which was afterwards exhibited for some years at the Victoria and Albert Museum. The notoriety of this collection led to a rather amusing experience. My father saw a fine Rhodian tile in a shop at Naples, but on inquiry was asked a quite exorbitant price. An attempt to bargain was met by the shopkeeper's reply that he had only to send it to Mr. Fletcher Moulton of London to get twice the price.

But the catholicity of his tastes led him rather to the acquisition of *objets d'art* of all kinds than to the formation of a specialist collection. In choosing these too he was influenced much more by their personal appeal than by their value from the collector's standpoint. Chinese and Japanese art in particular appealed to him very strongly, as did objects of the French Renaissance period and the works of the English silversmiths.

The widespread nature of his interests enabled him also to find something in common with almost everyone he met, and provided his companion really knew some subject, he would always find it, and come away with some information of interest. I think this contributed very largely to the general charm he exercised, since he left his companions with an increased idea of their own value.

So wide was his knowledge, and so vivid the

interest he showed in any topic of discussion, that his companion often had the impression that the subject was one to which my father specially devoted himself, whereas in fact it was probably one that he hardly touched on except when he met this particular friend.

During the earlier portion of his life in London my father was a very early riser. His work as a junior involved much writing in the form of pleadings and opinions, and he frequently started on these as early as 5 a.m. and had a shorthand writer with him by half-past six. It was only in this way that he could find the time for his experimental work with Mr. Spottiswoode. He had a great belief in the value of walking exercise, and usually walked both to and from the Temple, carrying a heavy brief bag. He has told me that one of the first effects of increased income at the Bar which he really appreciated was the fact that he could afford to have a clerk to take his bag home. He kept up this habit of walking in a modified form throughout his life, and even if he could not afford the time to walk the whole way to the courts, would do a mile or two before taking a cab.

Outdoor games played no part in my father's life. This was probably due to the fact that he had not taken any part in them at school or the University, and had a dislike of doing anything at which he was not expert. But he greatly enjoyed watching games, both indoors and out, and had a curiously complete knowledge of the big performances and records.

At Cambridge he played a good deal of whist and chess—in fact he was classed as the second-best whist player in the University. But he dropped both in later life—chess because he found it too fatiguing, and whist or bridge because he was afraid of falling below the standard of those who played regularly. He was in fact elected a member of the Portland, but was always too modest to play there.

My father was a member of the Alpine Club, and at one time did a considerable amount of climbing in his vacations. Some of his most interesting ascents were with Henry Fawcett—the blind Postmaster-General—who, in spite of his loss of sight, insisted on continuing all his favourite pursuits, such as climbing and skating, and my father had many long runs with him over the frozen fens. Later in life he abandoned the Alps in favour of the Dolomites, where he continued climbing till well over fifty.

On one of his climbs my father had an experience which he often quoted as showing the infinite subdivision of modern science. Arriving at a mountain top he stopped for lunch, and a few minutes afterwards a German came up the other side with whom he started conversation whilst they were eating. He soon found that the German was a chemist, and began talking of some recent improvements in alkali production. The German said he took no interest in inorganic chemistry. My father then turned to the production of saccharin, to be told that his hearer only studied dyes. A reference to rhodamine dyes,

as to which he had had a recent case, drew the reply that the chemist was only concerned with blue dyes. Undaunted, he then turned to synthetic indigo, to find that this too was barred, as the chemist's knowledge was confined to "methyl" blue dyes, which they then discussed at length, the German's closing remark being, "But the worst of a subject like the methyl blue dyes is that it is impossible to keep up with all that is being done in it."

It was rather remarkable that he could do such climbing, as at ordinary times he had by no means a "good head." He could not look down from any height, such as a cathedral tower, without becoming violently giddy, though he knew that he was in perfect safety, yet he had a power of self-control which enabled him completely to banish such feelings when engaged in hazardous climbing.

His favourite relaxation was at all times travel. When possible he avoided the railway, and at one time or another he covered most of Western and Central Europe by walking, bicycling, boating, or motoring. In later years the commencement of the Long Vacation always saw him start on a tour with one or more members of his family in which he would cover four to six thousand miles in his motor, carrying the whole of the necessary luggage, so that he should be absolutely untrammelled in his itinerary and could change his route from day to day as his fancy led him. One of these vacation tours started by a trip from Boulogne to Hamburg, from which he paid a

flying visit to Copenhagen, then via Central Germany into Italy and on through the Tyrol, and back via Berlin and Paris. At other times he would traverse in his motor-boat the canals of France, or reaching the Rhine via Holland spend the vacation in excursions up its tributaries. This boat was a very small one, though he managed to get quite a number of people on it. He usually kept it at some port in France, and at the outbreak of the war he placed it at the disposal of the French Red Cross, for whom it did good service. The crew of this boat was a home-made one, Lord Moulton considering himself as captain, his secretary Achille Bazire was navigating lieutenant, his butler was steward, and his chauffeur chief engineer. In it he was enabled to see many parts of France far off the beaten track, and to get back to a really simple life. He used particularly to enjoy bathing from this boat, as all his life he was a very good swimmer.

In 1895 he and I did a bicycle trip through Champagne. It was a somewhat hard journey for him, as the weather was terribly hot and he had only just begun to bicycle. In fact at the start his acquaintance with his machine was so slight that he could not mount unassisted, and on one occasion when, for some reason, I had to leave him about ten miles from our destination, Rheims, I parted with him with a filial injunction to go as far as he could without falling off, as I knew that once he did so he would have to walk the remainder of the way.

Undoubtedly France was the country that he chose the most. Her people and their ways were dear to him, and he was a real lover of the beautiful Gothic and Renaissance treasures with which she is endowed in such profusion. Here he would wander at random, avoiding the larger towns and above all the cosmopolitan hotels, seeking rather the little country inns where he would enjoy with ever-fresh wonder the best cooking of that nation of born chefs.

And then came the war, and many of the spots he loved best became scenes of horror. But the kindly fates let him taste once again the old delights, and in 1920 he enjoyed one of his most typical tours. Visiting first the Somme, he saw the devastated lands coming to life again. He was especially struck by the almost feverish energy with which the French workers were labouring to restore St. Quentin, destroyed, alas! by the shells he himself had provided. He followed the attack on the Hindenburg line at that most critical of points where the canal traversed the six-mile tunnel, which he knew of old through his boating experiences. Then on to the Aisne, where he tried in vain to trace the lines of that old castle of Coucy which he knew so well, that wonder of mediaeval fortification beside which Windsor Castle seemed a pigmy. Then on to Champagne, to an old and well-loved hotel at Chalôns-sur-Marne, from which he made the pilgrimage to Verdun along the Voie Sacrée, on which for so many months the stream of transport never ceased that alone brought help to the bulwark of France. From Verdun

he naturally went to liberated France, to Metz, where the voices he heard showed how, in spite of all "Verboten" notices, French had ever been the secret tongue. Then on to more peaceful scenes, to old-world Beaune and through the wonder of Western Europe, the gorges of the Tarn, to Toulouse and the Pyrenees, up to Paris, and then, having gone north and south, he traversed France from west to east—from Bordeaux to Strasbourg. A trip of pure delight such as he himself would have chosen for his last.

My father was a true amateur of all that was beautiful, and during these trips he indulged this taste to the utmost. From the Norman cathedrals of Caen to the old-world cities of Carcassone and Aigeus-Mortes there was hardly a monument of importance which he did not seem to know as a friend.

Another source of real enjoyment to him in these trips was the wonderful cooking and wines which the French inns provided. He was a great admirer of the *cuisine bourgeoise*—probably the best and most economical in the world. One of his constant laments was that "French cooking had not come into England from the bottom instead of the top"—that the English working-class had not been the ones to learn from their French compeers what wonders could be done with simple articles of food.

A new wine too was a special pleasure to him, and when he found a French inn where the cellar was really good, he ensured getting the best of it by the simple expedient of inviting his host to dinner and

asking him to choose the wines. This led to long and interesting conference in which both exercised their powers of criticism and comparison to the full. In fact with some of the older hotel keepers his status was rather that of a friend than a mere guest, and his opinion was frequently sought by them as to the prospects and comparative values of the recent vintages.

In the shorter vacations he made similar journeys in England, largely among the cathedral cities, for he knew and loved our architectural treasures as much as those of the Continent. He was generally gay—even to frivolity—on these trips, and one of the standard amusements was the composition of parodies of popular songs dealing with the adventures of the day, which were then performed by my wife.

In 1893 and again in 1899 he visited America, where he had many friends. Chief among them were the late Mrs. Katrina Trask, one of the most talented women in America, at whose beautiful home at Saratoga he passed part of his visit.

These trips were largely concerned with the orange groves of South California. Lord Moulton, in conjunction with the late Sir Herbert Praed, had been one of the pioneers in planting and growing citrous fruit in the Riverside District, near Los Angeles. The first attempt was made on land which had been unsuccessfully worked as a tin mine, and which seemed destined to be hopelessly derelict. The experiment proved successful, in spite of some climatic difficulties, and,

thanks to the efforts of these pioneers, Riverside is now the centre of a flourishing orange industry.

Another of his most intimate friends was George Foster Peabody, so well known in the States, not only for his financial ability, but for the work he has done towards the practical solution of the negro problems by social and educational means. With him he travelled over much of New England, and in his company he met President MacKinley shortly before his assassination.

His second visit to America was cut short by the sudden summoning of Parliament to consider the troubles that had arisen in the Transvaal. This was before the days of wireless installations, and when the boat left New York the passengers had to face a week's waiting for the knowledge whether England was at war. In fact most of them seemed more concerned by having to wait for the news as to whether or not the *Shamrock* had won the race which we had seen in progress as we left New York. No one then realised what the strength of the Boers was, nor how much the war would cost England.

To my father hospitality was both a rite and a pleasure, and he exercised it to the full in his home. His well-known parties ranged from a purely social function to gatherings of the Bar, or of representatives of science, and his talents as host were on a level with his more serious qualities.

Although these gatherings were one of the great pleasures of my father's life, it would be out of place

to attempt to give any account of them. A few were of particular interest, as, for example, a dinner given in 1912 to foreign scientists who were in London on the occasion of the tercentenary of the Royal Society, when the guests included the great Russian physiologist M. Pavloff. Like many of his most successful functions, it was organised on the spur of the moment, the guests being collected at a *conversazione* on the previous evening, and his daughter-in-law, who acted as hostess, was given the task of providing ladies for the guests with the stipulation that each must speak fluently at least two foreign languages, since many of the scientists spoke none but their own.

My father always took the greatest pains in arranging the details of his entertainments, equally so if preparing for a big social function or for receiving as guests the men of a battery, and he experienced a very real chagrin if—as was very rarely the case—some feature was imperfect.

Though extremely moderate in eating and drinking, the table was a real pleasure to him. He was probably one of the finest judges of wine in England, but never seemed fully to enjoy it unless he had an appreciative companion with whom he could discuss its merits.

Growing up as I did in constant association with my father, I feel that I may have taken so much of his social charm as a matter of course, that I am not capable of conveying the impression it produced on those to whom it came with all its freshness. I there-

fore welcome the opportunity of giving the picture of him furnished by a friend of long standing, Mrs. Walter Forbes :

“ My first meeting with Lord Moulton dates back through years it were unwise to count, but I remember well its occasion, a dinner party given by Mr. and Mrs. Oswald Crawford (a half-sister of Sir Clare Ford, who was then British Ambassador in Rome) at their charming flat in Queen Anne’s Mansions.

“ Our friendship was at once assured because of the affection that Mr. Fletcher Moulton, as he then was, bore to my brother George, afterwards Lord Justice Farwell.

“ He felt that I too must have a legal mind, and during dinner told me of a visit he had once paid to a French law court, when the case to be tried was that of a man accused of murder. The defence did not deny the accusation, the line taken being that the man was an excellent husband and father, that he had a large family, and that, were he sent to the galleys, this family would become chargeable to the State. He was acquitted.

“ The psychology of this verdict appealed strongly both to raconteur and listener, for, as has been said earlier in these pages, the psychology of other nations always interested Lord Moulton, and I cannot help feeling that his disinclination for such problems when dealing with his own country was a question of medium. We have no de Maupassant, whose works he knew almost by heart, and to hear him relate one of his short stories, bringing out every point and subtlety, was a real joy. It has been said that every

new language gives a new soul, and if this be so, Lord Moulton had in truth a very sheaf of souls. For him dead languages lived and living languages pulsed. Once when discussing d'Annunzio with him, I remarked how extraordinary it was that, in spite of the intricacies and subtleties of his style, and of my limited knowledge of Italian, his work so gripped and held me that I seemed to absorb its meaning without thinking about the words. He said that he too had felt this strongly in *La Figlia di Ioria*, written largely in dialect, yet which raised so powerful a picture that the strange, uncouth words seemed to strengthen, not to obscure, and he found an absorbing interest in the marvellous characterisation and development of racial passion in this drama. Lord Moulton had the faculty of so recounting that which he had read that it remained an abiding guest in memory.

"I once remarked to Lady Moulton that I failed wholly to understand how it was possible for her husband to find time for the foreign literature, books, reviews, and plays in three or four languages, which he not only read, but remembered and recounted. She agreed, but said she had a theory that he absorbed them through his elbow, by leaning his arm on the volume. If this be so, it was in truth a 'power to the elbow' which no Irishman has ever known.

"As playgoers, either at home or abroad, both Lord and Lady Moulton were the most delightful companions, for she too was an excellent linguist and had a dainty taste in books and plays, and also a real knowledge of music and of the opera, which Lord Moulton fully shared, and I never hear *Götterdämmerung* without thinking of an evening spent in their

box at Covent Garden, and of their discussion of plot, music, and Munich and Bayreuth methods. I have, too, vivid recollections in later years of Christmas holidays when I took my son to Paris and found Lord Moulton and his daughter-in-law also spending the vacation there. He would invite us to dine at one of his favourite restaurants, where, in all senses of the word, we discussed a carefully chosen dinner and admirable wine. Lord Moulton once said to me that, although of obviously minor importance, taste was as much a sense as sight or hearing, and that lack of it was lack of development. He realised the far-reaching effects on mind and body of careful choice in food and wine, the ruin wrought by badly cooked meals on health, temper, and happiness, and he deplored the view taken in England that ignorance of cooking is a sign of superiority, whereas on the Continent it is regarded as crass stupidity.

“ On one occasion when dining with Lord Moulton at ‘Henri’s,’ and drinking some admirable red wine, he told me how much interested he was in studying the qualities of these wines and forecasting the future of different vintages, and I know that his opinion was eagerly sought by the grape growers of Burgundy. He could readily give the vintage of any champagne upon tasting it, and on one occasion when dining with me and advised to take sherry after dinner, as it was from my father’s cellar and its date lost in the mists of antiquity, he placed it as 1820, a date subsequently verified by evidence from a contemporary cellar.

“ These little Paris dinners were, however, but a prelude—the play’s the thing. With Lord Moulton

it certainly was, and to follow with him fascinating turns of phrase and vivid characterisation was a never-failing pleasure. He was always deeply interested in national character, which he had studied closely, and this made him a most fascinating guide and companion through the pages of foreign books and before the footlights of a foreign stage.

"I especially recall a Belgian play which he had seen and delighted in at Brussels, and which was given in Paris two or three years before the war, when Christmas found Lord Moulton there with his daughter-in-law and my son and myself staying at the same hotel. He at once decided that we must all see this play, *Le Mariage de Mlle Beulemans*, and that my son and myself were to be of the party. To him, and to all of us, the subtle delineation of Belgian character, and the difference, often indeed opposition, of their point of view to that of the Anglo-Saxon, its variance also in many details from the French, were of absorbing interest, and his comments and appreciative criticism doubled our pleasure. This power of appreciation was one of his great gifts, so wide and so far-reaching was it, embracing all the arts and many domesticities in addition to the great subjects with which his name is eternally associated. During these visits to Paris old friends on pictures were revisited and the newest forms of art at least glanced at, when they could not hold, and I recollect a delightful evening when Lord Moulton, Mr. Frank Dicksee, and Miss Bartwick dined with me and the three discussed modern art while I listened.

"He delighted in opera, and delighted me one

evening when a box for the *Magic Flute* had been given to me by suggesting, in an *entre acte*, how admirable a list might be applied to critics were they invited to the first nights of operas as to which nothing had been allowed to transpire, no book of words, or programme furnished. The morning papers must then prove of thrilling interest, for he felt assured that every critic would give different readings both of characters and plot.

“Perhaps, however, Lord Moulton’s greatest charm lay in his power of conveying to each and every one with whom he talked the feeling that no one had ever really interested him quite so much before. As host, or guest, this quality was invaluable, for while those to whom he talked much had the substance, those with whom he talked little felt that they had the spirit which worldly duties had claimed too long. Also, as I have, I fear, too egotistically shown, he invariably discovered the subjects loved by those with whom he talked.

“Lord Moulton was an admirable host, whose equanimity no emergencies seemed to disturb, and when on the occasion of a very large dinner party at his house two people, invited for the following night, were announced, he merely murmured in his wife’s ear, ‘I will arrange it,’ and after cordially greeting the unexpected guests, vanished to readjust the series of round tables used at these parties. ‘I was paralysed,’ Lady Moulton (the most charming of hostesses) said to me, ‘and but for John, I feel that I should still be standing, a fixed and ghastly smile upon my face, gazing at those unexpected guests.’

“The strain of the smile and the hasty readjust-

ment of the tables were, however, wholly imperceptible to those assembled in the delightful main room on the ground floor opening on a garden in which the guests were gathered, and the predated arrivals remained in blissful ignorance of their mistake.

“Lord Moulton also possessed a marvellous faculty for making time, in the midst of most strenuous work, for other people’s interests, however insignificant, and I most gratefully recall how, during the war, he read the manuscript of the book I was then writing, *His Alien Enemy*, as to which I was most anxious to have his opinion. Much of its setting was familiar to him, and his kindly criticism and real interest encouraged me enormously, especially his eagerness to know my grounds for a scene where the Kaiser received the news of the Archduke’s murder. These I gave, and he was, I think, satisfied as to their foundation, although my theory did not fit in with one he had conceived. It was always his habit to ask, however inferior the mind to which he spoke might be, why a certain thing was thought before saying that it was wrong, and he regarded criticism as a vehicle for help and not for condemnation only. Lord Moulton loved his world of books, and possibly it was his power of leaving his world of work and, taking down some old and loved volume from his shelves, strolling into the pastures of literature, which enabled him to accomplish a task which would have overtaxed men many years his junior. He knew how to ‘browse’ amongst his books (as a Fellow of All Souls once put it to me), and, in thinking of him now, I realise that a friend with whom one has once thus ‘browsed’ is ever found again as the

familiar ground is retrodden and the old appreciations are recalled."

My father was an excellent raconteur, and his collection of stories included many amusing experiences in his own private and public life. One related to a German guest of his, who, trying to apologise for his wife's absence on account of her being subject to fainting fits, did so in the words, "My wife she is not fit for Society—if she does not lie she swindles."¹ He was fond of quoting Oscar Wilde's definition of a cynic, given at a dinner at Onslow Square, "A man who knows the price of everything and the value of nothing"—a definition which probably especially appealed to my father as representing the exact antithesis of what he was himself. One more story which I remember was as to his early days in the House, when an old politician came up to him in the Lobby and said: "Look here, Moulton, you're a young member, but even you ought to know there are some things the House will not stand. You gave —— a glass of water to-day and enabled him to bore us for a quarter of an hour longer than usual. See it doesn't occur again."

He had also a very choice fund of collected stories which he used with great skill, especially in his speeches. I remember how in his last speech, which he made at a dinner of the Imperial Industries Club a week before his death, he neatly side-stepped

¹ "Faint" in German is *Schwindeln*.

the glowing compliments with which his health had been proposed by telling a story of Father Healy, who, when a young lady said to him, "Father, if I were in the confessional I should have to admit the sin of vanity, for I can't help feeling when I look in the glass that I am very pretty," answered, "Oh! my dear young lady, that's not a sin, that's a mistake."

A few days before his death my father received an American visitor, Dr. John Finlay, President Wilson's colleague at Princeton University and now an editor of *The New York Times*, who came with an introduction from his old friend George Foster Peabody. After my father's death Dr. Finlay sent me the following very charming verses :

What fortune mine—crossing the Winter's sea—
To know for one brief hour the majesty
Of this most potent and most gracious mind
That wrought with mighty toil for all mankind—
A clear, compelling force, constraining all
It touched, as by the magic chemic thrall
Of some hid catalytic element,
Spending incessantly, yet never spent,

The earth was dearer to me yesterday
For that one hour before he went away.
'Tis sadder for that hour, this morrow's morn
Yet e'er will richer be, that he was born.

March 10th, 1921.

My father belonged to many clubs, but used most of them little. This was largely due to want of time, but apart from that I do not think that club life greatly appealed to him.

For one club he had a real love. This was the Savage Club, at whose Saturday dinners he often presided. The atmosphere of this club—with its five-fold qualification of professional connection with literature, art, science, the drama, or music—appealed to him strongly, for all these things he loved, and each man he met there had not only served his apprenticeship, but was really devoting his life to one of these ends.

The charm of the Saturday House dinners in the Old Adams room in the Adelphi is known to so many that I will not attempt to describe them. As chairman for the evening my father was able to introduce many guests of interest to the Club, and to whom the Club itself was equally of interest. On one occasion during the war his guests included representatives of all the Allied nations, another time they comprised a full Court of Appeal, while among other individual guests may be mentioned Sir Henry Campbell-Bannerman.

It is—or was—a strict regulation that there should be no speeches on these occasions. It is, however, a still stricter rule of the Club that none of its regulations should be allowed to interfere with the members' pleasure, so my father was generally permitted to contribute one of his delightful after-dinner speeches as his share of the evening's entertainment.

One of the features of these dinners are the menus prepared by some of the members, which usually

contain the most pointed allusions to the Chairman's habits and pursuits, together with more or less unflattering representations of the probable entertainers. One of these menus is reproduced in this chapter.

CHAPTER VII

THE FIGHT FOR AMATOL

THE shadow of the Great War first crossed my father's life when the news came of the assassination of the Archduke at Sarajevo. He surprised us all by the very grave views he at once expressed of the practical certainty of a great European War. At this time, although on some days the news bore a threatening aspect, few really anticipated war. But to him it seemed a certainty, a dread terror that had come at last.

I then found that, though he had never spoken of it, he had for very many years lived in apprehension of this great disaster. Probably his experiences at the outbreak of hostilities in 1870 had made the Franco-German War a more living thing to him than to most men, and he had felt from that time that it was but a prelude to a far greater catastrophe. The dread of this European war had always been with him, and this had increased with each step which he saw science take to make it easier to spread misery and destruction. His fear of such a war had no national basis ; it was founded on a realisation of the human misery which it must entail. He looked on it as the instrument

that would destroy the happiness of so many millions of homes.

His great human sympathy became a torment to him, as it enabled and even forced him to realise the sum total of private suffering that the super-war would cause. What he spoke and thought of was not the national danger, or the casualties to be feared in the field, but of the women and children to whom war meant unceasing anxiety or unspeakable loss, of the destruction of little homes, and of the possibilities of happiness represented by the little resources which the peasant or workman had accumulated.

Another, though far minor, fear was for the art treasures which he had so long known and loved. His travels had made him acquainted with nearly all the artistic and architectural beauties of Europe, and he realised how many of these might come within the zone of destruction. His apprehensions were too soon realised. Rheims Cathedral was to him almost the most cherished of all the triumphs of Gothic achievement. He had seen it but three months before, and seen it for the first time in its full beauty, since the repairs which had been in progress for a generation had at last been completed. I do not think I have ever seen him more keenly distressed than when the news came of the wanton destruction of this wonderful gift from the past.

But while his sympathies were universal for those who must suffer, he had the clearest opinions as to who were responsible for the coming war. Neither his

admiration for Germany's scientific triumphs, nor his personal friendships there, caused him for a moment to overlook the deliberate intention of the German war party to force a conflict, or to hesitate as to the course that our country should take ; and during the latter part of July there was added to his other anxieties some fear lest we should fail to do our duty.

I think his apprehensions, and his views as to Germany's intentions and conduct, may be best gathered from an extract from the Reade Lecture delivered by him in 1919 :

“ All these advances in knowledge and power of which I have spoken concern intellect only and not character, and we are learning to our cost that no development of intellect necessarily brings with it moral growth. No better proof could have been vouchsafed to us than our recent experiences. For at least half a century Germany had stood first among the great nations in its care for the education of its people. Science was everywhere cultivated and made accessible to the whole nation. Even allowing for the exaggeration of its claims due to its persistent self-glorification, I do not doubt that the boast of the Germans that their country could show a larger proportion of men of scientific attainments than any other was substantially justified, and no doubt the influence of these men on the thought of their country was proportionately great. Yet we find Germany during a period of at least twenty years consciously and deliberately making preparations for a war to be waged upon its neighbours solely for the purpose of

self-aggrandisement. When the war was at last commenced it was acclaimed and universally supported by the nation. That it opened with a flagrant and undisguised breach of national faith affected the people not at all. At no time did they seek in any way to mitigate its horrors, but made it their aim to increase them. Common soldiers co-operated with their officers and the higher commands in carrying it out with calculated and revolting brutality to the civilian population of the invaded countries. Finally they introduced the use of asphyxiating gas and all the tortures of so-called chemical warfare. They thus realised the image which has been before my mind throughout this war when thinking of their ideal of the individual and of the nation—that which they would have science and education make them. It is the monster which the Frankenstein of Mary Wollstonecraft created—a human being with his powers magnified to those of a giant but destitute of moral sense.”

But while he never hesitated as to our duty to oppose Germany, he realised to the full what the task meant. He knew the strength of the Central Powers and that their available forces would for many months be far greater than those of France and Russia combined, and he realised that if victory were to be obtained, it could only be after a war of years.

The depression of which I have spoken increased after the outbreak of war. Feeling as he did that victory could only be gained by an absolutely universal effort, the very slow progress of recruiting and armament filled him with despair and disgust. Further-

more there seemed to be no task he could do—a torture to his essentially active mind. I think that for the first—and only—time in his life he felt he was an old man.

But early in September this inactivity ceased. From the first it had been clear that if our trade in textiles was to continue, steps must be taken to replace the dyes we had hitherto drawn from Germany, and Lord Moulton was asked to undertake the task of collecting the necessary supplies for this purpose. Immediately his melancholy disappeared and was replaced by an astounding activity. The task was no light one. Dyes mean coal tar, and the comparatively small demand there had hitherto been in England for this had led to much of this coal tar being allowed to go to waste. To save this meant the adoption of entirely new methods, but in a few weeks the necessary steps had been taken to ensure large supplies of the raw materials for these dyes.

But much of these supplies never reached their destination. The dye-makers were not alone in needing coal-tar products—the War Office was even more clamorous for them. Adopting the old principle that the poacher makes the best gamekeeper, Lord Haldane and Lord Kitchener asked Lord Moulton to preside over a newly formed Committee for Explosive Services, and in this new capacity he promptly commandeered a large portion of the supplies he had been preparing for the dye industry.

The summons to this fresh work arrived when Lord

Moulton was investigating supplies in the West of England, and was couched in such urgent terms that he immediately set off in his car for a run through the night to London. This opening step in his future career nearly led to its untoward termination. The national emergency had possibly led even such an upholder of the law as Lord Moulton to treat the regulations as to speed limit somewhat lightly; at any rate, just after passing a man on a bridge, he suddenly heard a challenge and also an ominous sound, which he had probably last heard at Saarbrücken, and which he recognised as the cocking of a rifle. The car was pulled up just as the sentry—for it had run past an emergency post—was preparing to pull the trigger. Luckily the telegram from the authorities was considered sufficient explanation of the speed of the car, and Lord Moulton was allowed to proceed to London and his new duties.

I may here mention one curious effect which these new duties seemed to produce. Whereas before he was sending out for every paper and eagerly studying every bulletin, once he became responsible for explosive supplies he seemed to turn into one of those curious persons who took little or no interest in the war. He seldom read a paper, and seemed quite satisfied with such fragments of news as his friends gave him. I have no doubt that this was done deliberately, because he feared that if he worried himself with war news it might interfere with his power of giving his absolutely best work to the

provision of supplies. As he once put it, "He was in the stokehold, and his business was to keep the steam up for the engines and not to worry about what was going on on deck."

This apparent aloofness did not extend to the men who were fighting, and many of those in France had cause to be grateful for his generous gifts.

During the next four years Lord Moulton was so wrapped up in his duties at the head of the Explosives Department that to tell the history of his life involves telling much of the story of explosives production. This is the less to be regretted, since the public even now know far too little of the wonders worked to give our Army and Navy the ammunition that spelt victory.

Lord Moulton's first position in this connection was that of chairman of a small committee consisting of himself, Dr. Charles Carpenter, Major Cooper Key, Dr. W. R. E. Hodgkinson, Sir Sothern Holland, Mr. W. McNab, and a representative of the War Office. This committee first met on November 15th, 1914—the day the Germans were finally beaten off at Ypres—its duties being to consider and advise on the steps to be taken to ensure an adequate supply of high explosives. The life of the committee as such was a short one, since it soon became clear that executive rather than consultative powers were needed, and a report to this effect was presented at the end of November. The chairman and a small staff immediately took up their quarters at the

Institute of Mechanical Engineers in Storey's Gate, and proceeded to develop the organisation which presently grew into the Explosives Supply Department. From this date the committee as such practically disappears, though many of its members subsequently rendered invaluable services to the country in the work of explosive supply.

It was evidently a working rather than a formal body. "We often used to meet," a member has told me, "at a room at the War Office, belonging to one of the Committee, who had also to sleep there. I well remember Lord Moulton arriving at nine o'clock in the morning, sitting down beside the bed which its occupant had just left, and working on there probably until midnight."

It may be well here to consider the nature and extent of the problem which Lord Moulton and his helpers were called on to face.

The scale and system on which the British Army had been organised in the past had rendered the question of explosive supply a simple one. The wars in which it had been engaged in recent times were wars in which the problem was rather to catch your enemy than to deal with him when caught, and consequently the average daily expenditure of ammunition had been small. The manufacture of explosives could therefore be effectively dealt with by a few Government factories and private firms, and no preparations had been made for any increase in the scale of production.

Further, the class of ammunition usually employed had been such as to place the minimum strain on these resources. Although high-explosive shell had been used to some extent in the Boer War, the general feeling was that shrapnel, whose only explosive content is about an ounce of black powder, must be the stand-by of land artillery. In the Navy it is true high-explosive shell was almost invariably used, but large quantities of such shell had gradually been accumulated, and there was no anticipation of such large and continuous expenditure of ammunition as to lead the authorities to establish great factories for its rapid supply.

Of course similar facts as to the insufficiency of existing sources of supply had to be faced with regard to nearly all items of military equipment. But in most cases the demand could be met by establishments already organised for civilian purposes. If the War Office wanted boots—even though these were required of the sealed pattern—there were numerous boot factories at hand. If guns or shells were demanded, at least the iron foundries and steel works existed—all that was required to meet the demand was reorganisation and the provision of additional plant. But in seeking extra explosive supplies there was little or no help to be obtained from trades established for civilian needs. A few high explosives had been manufactured for mining purposes—a little propellant for sporting cartridges—beyond this there was nothing.

By the time Lord Moulton's services were called for the world had realised that a new era had appeared in warfare. From the time of the attack on Liège it was clear that heavy guns and howitzers of the largest calibre would be continually at work in the field, while the battles of the Aisne and the continual extension of trench lines towards the North Sea showed that artillery must be prepared for work on an unprecedented scale.

How this worked out in practice may be judged from the fact that while at the commencement of the war our actual establishment of siege batteries—the gluttons of high explosive—was only two six- and one eight-inch, over five hundred and fifty siege batteries were formed before the war was over.

By his very success the gunner had created new and formidable problems for himself. Liège, Namur, the Marne had shown how incapable any visible target was of resisting modern artillery, so the armies of both sides had disappeared from view and left the gunner as his only target the straggling lines in the ground formed by his enemy's trenches.

The full effect of the change to trench warfare on the expenditure of ammunition is perhaps not generally appreciated. If you aim correctly at a man in the open with a rifle, you will hit somewhere at ordinary distances even if you are five hundred yards out in your estimate of range, since for that distance the bullet is within his height of the ground. Similarly with shrapnel you will hit him over a

distance of one hundred and fifty yards. But if he is in a trench, your shell must drop within a range of from two to five yards or it will probably be harmless. Further, even if you get the shell into the trench, it by no means follows that a man is there, and this means a further waste of ammunition.

Again this accuracy in range is far more difficult to obtain than accuracy in line. Under good conditions the majority of shells could probably be made to pass over a breadth of five yards—but the gunner would be lucky who got one in ten to fall within a range of five yards.

I have enlarged on this point to indicate the great effect the change to trench warfare might be expected to have on the necessary expenditure of ammunition, and this expectation was fully borne out. It was said that at Waterloo it took a man's weight in lead to kill him—figures indicate that in the present war the weight of projectiles per fatal casualty was over a hundred times as much.¹

Though these facts were becoming plain when Lord Moulton was called in, few if any steps had been taken towards procuring a supply of ammunition corresponding to these new conditions. Apparently it was considered that the old sources must suffice

¹ The total amount of high explosives provided by the Explosives Department was over 600,000 tons. Assuming that only half this quantity was used by the British forces in the field, and that the total weight of the projectiles was ten times that of the high explosives, we get a weight of 3,000,000 tons of projectiles which at the Waterloo rate would have accounted for 40,000,000 men killed by high explosives alone.

and that the only steps which the War Office could take—consistent with the preservation of its self-respect—was to ask for further tenders in due form from contractors on the authorised list.

The output of high explosives at this time was about a ton a day—Lord Moulton raised it before the end of the war to over a thousand tons a day.

By the end of 1914 it was decided to make the organisation he had created a branch of the War Office. It was to be known as A.6; but as the War Office was unwilling at that time to recognise the direct orders of a civilian, Brigadier-General W. Clare Savile was appointed as its representative and the executive authority was to be exercised by him and Lord Moulton jointly.¹

This new department had the general supervision of all contracts for high explosives and of measures dealing with their production, from the raw materials to the finished product in a state to satisfy War Office requirements.

From the first my father appreciated the true scale of our requirements, and—in the words of Dr. Farmer's obituary notice—"thought in tons while others thought in pounds." By the end of November 1914 he had prepared a programme for developing the supplies of raw material which embraced every

¹ I should like here to record the gratitude my father so frequently expressed for the great assistance and unfailing courtesy he received from General Savile, who, so far from putting any official difficulties in the way of his far-reaching plans, supported them most enthusiastically and effectively.

gas works and coke distillery in the country, and in January 1915 he was able to promise by the following March supplies of explosives not only adequate to our own resources in shells, but sufficient to afford substantial help to our Allies.

His task was complicated by the fact that just after the outbreak of war the authorities had decided to change the high explosive to be used from picric acid (commonly known as lyddite) to tri-nitro-toluene or T.N.T. No doubt this decision was a wise one. T.N.T. is one of the safest of explosives, while picric acid demands great precautions in manufacture, filling, and storage. But while the choice may have been wise, it meant that the immediate possibilities of supply were even less than before, since the explosive factories in existence were mainly designed for the production of lyddite rather than T.N.T.

Lord Moulton took the view from the first that the limits of our production of T.N.T. would not be fixed by considerations of the capacity of the works of authorised contractors, nor even by that of new works to be established, but by the amount of raw material that could be obtained.

Every three tons of T.N.T. required about two tons of toluene.¹ The only practicable source of toluene, with one exception,² is coal, which contains

¹ I am referring to the then current conditions. Better yields were afterwards obtained.

² A large amount of toluene was derived from Borneo petroleum (see page 202).

about $3\frac{1}{2}$ lbs. per ton, so that on an average 600 tons of coal were required to be coked to give a ton of toluene. It was at once evident to Lord Moulton that the total amount of toluene produced in this country was nothing like sufficient to give the required amount of high explosive, even if the dye industry, which largely depended on it, were wholly neglected.

As a first step, however, measures were taken by which A.6 got the call of all the toluene produced, and these were supplemented by measures (referred to later) to increase the yield of toluene obtained per ton of coal.

But the amount of toluene was still far short of our wants, and the earliest of Lord Moulton's reports emphasised the necessity of employing other substances derived from a different source. This view seemed to come as a complete surprise to the War Office, who at the commencement of the war had actually refused offers of lyddite on the ground that they had decided that T.N.T. only should be used.

The Department therefore similarly surveyed the possible sources of production of lyddite. Here the task was easier, since this can be produced either from carbolic acid or from benzene—both of which were obtainable in fairly large quantities.

But even this left the supply far short of what was necessary, and the first serious conflict that arose between A.6 and certain of the military advisers of the War Office was over the adoption of other groups

of substances for explosives which depended for their production on different raw materials.

Modern explosives as generally used in warfare are compounds of carbon, oxygen, nitrogen, and hydrogen, which, on being detonated or exploded, spontaneously generate great heat and at the same time produce great quantities of gas—nitrogen, carbonic acid, and steam—which, expanding under the influence of the heat, give rise to the intense pressures characteristic of such explosives. But there are many compounds of this character which, although they have the capacity for the production of the necessary heat and gas, are yet not explosives in themselves, since under ordinary circumstances the heat and gas are produced too slowly to cause an explosive effect.

One such is ammonium nitrate, which by itself is a quite harmless substance, but if intimately mixed with T.N.T. it is turned by the explosion of the latter into an explosive of the most powerful class. From such a mixture we get therefore a new explosive as powerful bulk for bulk as pure T.N.T.,¹ and this gives a means of multiplying many times the effective stock of T.N.T.

Ammonium nitrate has the great advantage compared with T.N.T. that, whereas the latter depends on the supply of toluene, a by-product of commercial operations such as gas making, the production of which is strictly limited, the former is obtained from a raw

¹ It may be said to be even more powerful, since T.N.T. has a slight deficiency in oxygen, while ammonium nitrate has a surplus.

material—Chile saltpetre—of which we could, thanks to our command of the sea, obtain any quantity necessary. On the other hand, the mixture of the two substances is somewhat more difficult to detonate than T.N.T., and it is therefore necessary to place a small quantity of pure T.N.T. in proximity to the detonator, which is easily detonated and passes this detonation to the remainder of the explosive.

These facts undoubtedly made pure T.N.T. an easier substance for the designer of ammunition to deal with, and hence the War Office choice had fallen on pure T.N.T. as our standard high explosive. But in Lord Moulton's view the question of convenience was far outweighed by the fact that the use of ammonium nitrate combined with the T.N.T. would mean a manifold increase of our stock of explosives.

The struggle to obtain the adoption of this compound explosive, subsequently known as amatol, was a long one. There is no doubt that certain of the military authorities objected to civilian interference where they had made their decision and urged the technical difficulties to the utmost. To this Lord Moulton retorted that the Germans and other Continental nations were using these explosives in the field, and if their artillerists had been able to solve the problem of effective detonation of the mixture, ours could do the same. Finally in February 1915 Lord Kitchener, who also "thought in tons," gave his casting vote on the side of big production, and A.6 were

told they might proceed with the production of amatol.

Even had he done nothing but obtain this decision, Lord Moulton would have performed a service of almost inestimable value to the country. But for the adoption of amatol it is very doubtful if we could have provided one-third of the high-explosive shells in fact supplied to the military authorities.

Although the main question was thus decided, minor, but still very important, points remained. At first the form of amatol adopted by the ammunition makers was the 40-60, i.e. 40 per cent. of ammonium nitrate to 60 per cent. of T.N.T. The rival mixture—naturally favoured by A.6—was 80-20, i.e. 80 per cent. of ammonium nitrate to 20 per cent. of T.N.T. The former had the advantage from the ammunition makers' standpoint that at 80° F., a temperature to which it could be safely heated, it formed a liquid which could easily be poured into shells, while the 80-20 had to be rammed in in the solid form. Many of the early shell-filling factories (these factories were not under A.6) were consequently designed for the first mixture, but subsequently the 80-20 mixture, which produced five tons of high explosive for each ton of T.N.T., was adopted for the bulk of our shells.¹ For some special purposes, such as naval shells, pure T.N.T. was still retained.

Some further alterations were found to be necessary

¹ One ton of toluene will give enough 80-20 amatol to fill about 2,000 6-inch shells.

for the most effective utilisation of these new explosives. As has been pointed out in the footnote to page 189, amatol is a more perfect explosive than T.N.T., but it produces very little smoke. Now the artilleryman wants smoke, since it enables him to see where the shot has fallen, and so make any corrections necessary. Further, he is apt to judge whether a complete detonation has occurred by the amount of smoke produced, and at first the smokelessness of the amatol shells often produced the impression that they had failed to explode at all, or that the detonation was incomplete. These difficulties were surmounted by adding a small amount of a smoke-producing mixture to amatol shells.

Lord Moulton's programme was never limited to the demands of the British Empire. He always recognised that the success of the Allies necessitated that all should be sufficiently supplied with explosives, and also that most of the Continental armies were severely handicapped in this respect. The Belgian Army must clearly depend entirely on supplies from external sources. France had lost her best coal districts, and with them the supplies of toluene which that coal would have produced, while our Eastern Allies were particularly backward in the means of explosive supply. Therefore from the very first he had to keep his output up to a point that would not only suffice for our own production of shells, but would enable him to comply with the requests for a hundred tons here and a hundred tons

there which were so forcibly and frequently made by our Allies. How urgent was the need that led to these demands was shown by the fact that, in the early part of the war, we sent supplies to the French who, to save time in the supply of shells to their troops, filled them practically on the field of battle.

At the same time that he was making these preparations for the increase of his future supply of raw materials, my father had to ensure the maximum and quickest output of finished explosives from the toluene and carbolic acid which he had in hand. This task was of the hardest, since he could not afford to depend only on the firms who were accustomed to the production of such explosives, but must also seek the help of many manufacturers who had no such experience.

Naturally the results obtained by these new firms varied very greatly, and while many from the first did excellent work, others were continually in arrears with their deliveries, or were taking the precious toluene and producing perhaps only one-third of the proper amount of T.N.T. To meet these difficulties a most efficient system of inspection was established, and the head of the department himself was continually visiting the manufacturers in order to acquire first-hand knowledge of their progress and difficulties, and to take, with the minimum of delay, the steps necessary to ensure the required production.

The reader will probably remember how great

was the demand by our troops in the early part of the war for high explosives and how they suffered from the shortage of these. It may therefore be well to explain that the real shortage from which they suffered was not of high explosives, but of shells suitable for containing them. It was the boast of A.6 and the Department that followed it that they never kept a shell waiting, and in spite of all the difficulties that surrounded the production of explosives at this time, their supply was always more than adequate for the shells that could be produced.

It is of course impossible in a brief review like the present to preserve any strict chronological order in regard to the manifold activities of such a Department as that under my father's charge, and many of the changes to which reference has been made were in reality spread over months or years.

In June 1915 a change took place in the status of the Explosives Department, which was transferred to the newly established Ministry of Munitions and given the title of the Explosives Supply Department, Lord Moulton becoming Director-General of Explosives Services. The new Department then assumed, in addition to its former duties, the work with regard to contracts which up till then had, nominally at least, been performed by the Master-General of the Ordnance, General von Donop. Sir R. Sothorn Holland became Deputy Director-General, and General Savile Military Adviser to the Department.

Little change was in fact made in the organisation

of the Department. It had sprung into existence before other similar departments, and its functions differed in that it had to create rather than to control manufacture. For these reasons it was thought well to leave it with the organisation which had already proved successful in practice rather than to attempt to bring it into line with the more newly formed departments. In particular its staff was completely self-contained, and had its own sections for dealing with such questions as labour, transport, and housing, which in the cases of other departments were generally controlled by outside organisations.

The new Department was responsible for the manufacture both of propellants and of high explosives.¹ The propellant in general use in this country at the outbreak of war was cordite. Cordite was one of the most remarkable inventions of the last century. Its components are nitro-glycerine and gun-cotton—explosives which are so violent and dangerous that they cannot even be used in shells, yet the great chemist Nobel found that by their union they produced a safe and steady propellant which, in addition to its other advantages, was practically smokeless. Unfortunately for himself he only claimed in his patent the manufacture of this explosive from one particular species of gun-cotton, and the Ordnance Department chemists found that

¹ Except propellants for the Navy, which continued to be manufactured in Admiralty factories.

a similar propellant could be manufactured from another species without infringing his claims.

In the action which followed, Mr. Fletcher Moulton (as he then was) was counsel for Dr. Nobel, and though he was unable to obtain success owing to the defect in the patent, the knowledge of explosives which he thus obtained was of the greatest use to him during the war. Possibly too the prominent part he had played in this case may have been one of the reasons why he was originally asked to take charge of the Committee of Explosives Supplies.

Although cordite was the chief propellant during the early part of the war, it was subsequently largely replaced by nitro-cellulose powders, i.e. powders containing no nitro-glycerine, but formed of a low-nitrated cotton. One of the reasons for this change was a curious one. Glycerine was almost entirely a by-product of the soap industry, being the residue left when vegetable oils are converted into soap by the addition of soda. The need for replacing butter by margarine led to the diversion of much of this vegetable oil from the soap industries, and the restriction in the output not only of soap, but of glycerine, and therefore of nitro-glycerine. These new powders had the advantage of causing less erosion in the guns—on the other hand, they did not give so high a muzzle velocity. A further advantage was that their manufacture did not require acetone. At the same time a new form of cordite—cordite R.D.B.—which likewise did not involve the

use of acetone was brought into use by the side of the simple nitro-cellulose powders.

The supply of propellants formed a sub-department of the Explosives Supply Department, and was first under the charge of Major Bagot, who was succeeded in December 1915 by Sir Frederic Nathan, who had been released by the Admiralty for the purpose.

Prior to the war the propellants for the services had been manufactured by Government factories, so that there was not quite the same novel organisation needed as in the case of high explosives. Immense expansion of supply was, however, necessary, and this was partially met by the erection of two large factories—at Gretna and at Queen's Ferry near Chester.

The bulk of the nitro-cellulose powder used was, however, obtained from America. The main reason was that this saved tonnage space in ships, since all the materials had to be imported, and if imported in the raw state they occupied seven tons of space for every ton of completed material. Taking cordite and nitro-cellulose together, almost exactly equal quantities of propellants were produced at home and abroad.

Although the expansion in this respect was nothing compared to that in the case of high explosives, it was sufficiently remarkable, the home production rising from the rate of 12,000 tons per annum in the last five months of 1914 to 100,000 tons in 1917.

The high explosive is a comparatively new factor

in warfare, having first attained importance during the Boer War. In these explosives the utmost suddenness and violence of effect is sought, but they must also be comparatively safe to handle, and must generally be able to withstand not only the shock of firing, but the far more sudden shock of impact without explosion, which should be entirely controlled by the fuse. This last consideration does not apply to explosives used for such purposes as mines.

Lyddite (picric acid) had been the sole service shell-filling up to the outbreak of war, the decision to change to T.N.T. only being made in September 1914. In the first two years of the war it was undoubtedly the artilleryman's favourite explosive, both because many officers had been familiar with it during the Boer War, and also on account of its greater apparent effect, due to the larger quantity of smoke. Further the service fuses had been designed for use with lyddite, and it was some time before the necessary experience of the newer explosives enabled a fuse and gain to be made which showed their full value.

Picric acid is made from phenol, which is itself a constituent of coal tar, and can also be formed from benzene. Lord Moulton was therefore anxious to make full use of lyddite, since its production did not trench on the limited stock of toluene. But unfortunately picric acid had only been manufactured on a very small scale—chiefly for dyeing purposes—by methods which had remained unchanged for a

century. A system of large-scale production had to be devised—a matter of some difficulty, since picric acid must not touch metals. The process was found and four factories erected by the early part of 1917.

But by this time circumstances had changed. The service had been converted to the view that 80–20 amatol was just as effective an explosive as lyddite, and 80–20 amatol could be produced in quantities sufficient for the existing shell programme. The most urgent question of the moment was that of saving tonnage, and the imported materials necessary for the production of a ton of this amatol was less than one third that required for a ton of lyddite—a proportion which applied also to the respective costs of production. It was therefore finally decided to abandon lyddite, and the new factories were diverted to other purposes.

This occurrence illustrates to some extent the difficulties under which my father laboured. The amount and nature of the demands of the military and naval authorities were subject to the most complete and unexpected changes, which rendered nugatory the best-laid plans of the Supply Department.

T.N.T. (tri-nitro-toluene) had prior to the war only been used by the Army for a very limited purpose—the filling of exploder bags. For some years, however, tests of its suitability for shell filling had been proceeding, and in September 1914 it was decided to adopt it as the service explosive. Naturally there

was no Government factory in existence for its production and little knowledge even of the required specification. At first sight its manufacture presented no difficulties, since our coal resources promised large supplies of toluene, but when the matter came to be examined quantitatively, difficulties at once appeared, the chief of which was that owing to the small scale of our dye industries, coal distillers were not troubling to recover more than a small portion of the toluene contents.

The first step taken was to ascertain and obtain control of the existing supplies of toluene, and following the recommendation of the Explosives Committee the Government in November 1914 commandeered for the duration of the war all supplies of toluene or substances containing it. In the process of tar distillation, the spirit, etc., produced is divided into parts according to the temperature at which the spirit boils. The portions usually sold as benzene, toluene, and naphtha come over in this order, but the divisions are not sharp, and much, in some cases most, of the toluene is to be found in the benzene or naphtha. It can be separated from these by redistillation, but this was not generally thought to be worth while, especially as the presence of toluene in benzene improves the latter by rendering it less liable to freeze.

In order to save this toluene the sale of benzene or naphtha containing more than 3 per cent. of toluene was forbidden, unless special permission had been

obtained, and large supplies of toluene soon began to come in from this source. As an example of the work of the Department it may be mentioned that during the course of the war nearly 40,000 samples of benzene were examined to see if they complied with these requirements.

But more formidable difficulties attended the attempts to stop another door by which toluene disappeared. It was not only at the tar distilleries that this precious substance was used to enrich other products, for the gas companies designedly allowed a portion to go into the gas, whose illuminating properties were thereby greatly improved. Since the gas was required by law to reach a certain candle power, the toluene so abstracted had to be replaced by some other substance, and at first benzene was used, but subsequently this too became too valuable to burn, and no equally efficient substitute could be supplied. To meet this difficulty a heating standard for gas was substituted for the previous illuminating standard—a change producing little real discomfort in view of the almost universal use of mantles, and finally an order was made under the Defence of the Realm Act which relieved the gas companies from any penalties for failing to supply gas of the proper standard if such failure were due to their compliance with the regulations of the Explosives Department.

These legal difficulties were of course supplemented by technical ones relating to the actual extraction of the toluene. This involved the installation of

additional scrubbers, or apparatus designed to remove coal-tar products from illuminating gas. These difficulties were lessened by the willingness shown by the gas companies and coke-oven operators to co-operate with the Department, and a most efficient system of scrubbing the gas by means of a stream of coal tar was devised by Dr. Carpenter of the South Metropolitan Gas Works. Thus the gas companies alone were enabled to contribute an additional 5,000 tons of toluene per annum.

These measures exhausted the possibilities of producing toluene from home sources, and though they promised an immense increase in the explosive supply, this was yet far from reaching the demand necessitated by the programmes of the military and naval authorities even in 1915. Many sources for supplementing these supplies were suggested, but only one proved practicable—the extraction of toluene from Borneo petroleum. This petroleum contains about 10 per cent. of toluene, and at the outbreak of war was being treated in a factory at Rotterdam. In January 1915 a contract for the acquisition of the whole of the plant of this factory was made, and the removal of the plant was begun at the end of the month, and by the beginning of April the factory was working full capacity in this country. The importance of this source of supply will be appreciated when it is stated that it eventually produced 8,000 tons of toluene per annum, an amount equal to the whole pre-war production of this country.

The apparent disadvantage that each ton of toluene obtained involved the conveyance of ten tons of petroleum overseas was greatly minimised by the valuable nature of the remaining products of this petroleum.

When all these sources of supply had been tapped, Lord Moulton had sufficient picric acid and T.N.T. in sight to meet the immediate demand for shell-filling in the early part of 1915, but he realised that his resources could not possibly be expanded so as to keep pace with the extended shell programmes that were being prepared. It was for this reason that he so ceaselessly and persistently urged the production of mixed explosives, the use of which was authorised for all classes of army shells by a series of decisions starting in February 1915 and extending to October 1916. These explosives employed both T.N.T. and ammonium nitrate, which latter substance is produced by treating ammonia or ammonium sulphate either with nitric acid or one of a series of nitrates. It therefore had the advantage that one of its main constituents—the most difficult to obtain, viz. ammonia—was, like toluene, produced in this country and in far greater quantities. The sulphuric and nitric acids or nitrates must be imported, but the supplies were ample, and Lord Moulton assured Lord Kitchener—and this assurance was made good—that if the use of these mixed explosives were permitted, he could meet any demands that might be made on him by the fighting services.

The chief difficulty with regard to the manufacture of ammonium nitrate was to find an economical process of large-scale production which did not demand the use of nitric acid. In the latter part of 1916 Dr. Freeth, a chemist in the employ of Messrs. Brunner, Mond & Co., who had been called back from the front for chemical work, worked out a process for the direct production of ammonium nitrate from ammonium sulphate and Chile saltpetre, and a large factory for its exploitation was immediately begun at Swindon. The production of this explosive was expanded from 50 tons weekly in the early part of 1915 to over 4,000 tons weekly during parts of 1918.

A great many coal-tar products other than phenol and toluene can be used to produce explosive substances, and the possibility of broadening the basis of our supply of raw materials for explosives by their use was fully considered by Lord Moulton. In some cases, however, technical difficulties arose owing to the want of stability or the difficulty of detonation of the explosives so made, and in other cases, as for example in the case of naphthalene and cresol, it was thought they could be most usefully employed by being supplied to our Allies, and especially to France, who were already using explosives formed from them.

In addition, detonating mixtures had to be provided for high-explosive shell. Here the difficulty lay rather in the choice of the best material than in the subsequent large-scale production.

But neither the responsibilities nor the difficulties

of the Explosives Department ended with the provision of phenol, toluene, or ammonia. These substances had to be developed into explosives, and the materials for this development had to be found.

Lord Moulton often remarked on the rôle played by nitrogen in explosive manufacture as one of the most curious phenomena of chemistry. Nitrogen in its free state is about the most inert substance known. It shows no tendency to affect or unite with any other substances. Its rôle in nature is merely to provide a diluent for the oxygen of the atmosphere which alone would be far too strong for our lungs. But, to use my father's words, "its real nature comes out when it is joined in matrimony with other substances." Its sluggishness disappears as if by magic, and nitrogen compounds as a whole are among the most energetic and unruly of chemical substances.

In particular, nitrogen—usually in the nitro or nitrate form—is a constituent of all the most common explosives in which it plays a twofold rôle. Firstly, it imparts that instability which leads these compounds to change readily to others, with a great evolution of heat, and, secondly, it provides volumes of gas which under the influence of heat rise to the high pressure which propels or bursts the shell. Consequently the primary substances such as toluene need development by being converted into nitro bodies, and for this purpose nitric acid is generally necessary, though sometimes a nitrate such as salt-petre (sodium nitrate) can be used.

Nitric acid was of course a substance commonly used in trade, but to nothing like the extent that was certain to be required for the large-scale manufacture of explosives. The Department had therefore to arrange for its production on a very large scale. The reluctance of nitrogen to unite with other substances renders combined nitrogen a comparatively rare substance in nature. The great source of world supply are the beds of sodium nitrate in Chile (which were probably formed from organic sources), and those had been drawn upon by this country for many years, the nitrate being used partly for the manufacture of nitric acid, but chiefly as a fertiliser.

This importation increased five-fold during the war, in spite of the fact that a large part of these nitrates, which had formerly been used as fertilisers, was diverted to the purpose of explosive manufacture. Of course this importation, running into many hundreds of thousands of tons per annum, imposed a great strain on our shipping, more particularly as these nitrate ships were a special target for the German submarines, and this rendered the supply of nitrates the most delicate of the links in the chain of explosive manufacture. The anxiety in regard to the reserves of nitrates was especially acute in 1918, when labour trouble in Chile threatened to cut off this supply at its source.

It was at one time hoped that this strain might have been reduced by manufacturing nitrates here by the Haber process. This process depends on bringing nitrogen and hydrogen together at a very high tem-

perature and pressure, in the presence of a substance—known as a catalyst—which facilitates their combination. The general outlines of the process had been published, but the technical details necessary to success on a commercial scale were very jealously guarded in Germany, probably with a view of its utilisation for war purposes. The possibilities of starting the process in this country were carefully explored by Lord Moulton, who reluctantly decided that our scientific arrears of knowledge in this respect were too great to enable us to rely on such manufacture during the war. Very many investigations were, however, conducted under the directions of a committee formed for this purpose which may have an important effect on our post-war industry.

My father was always of opinion that but for the development in Germany of the process for the fixation of atmospheric nitrogen, she could not possibly have continued the struggle for long, since our control of the seas cut off the possibility of the importation of the nitrates necessary for her explosives manufacture.

The other necessary substance was sulphuric acid. For this again the bulk of the raw materials had to be imported, but the pre-war manufacture had been on a far greater scale, and the only great shortage was in one variety—oleum—used in the last stages of nitration. This shortage was met at first by importation from America, and subsequently by the erection of new factories.

It will thus be seen that the supply of acids entailed

a very heavy strain on our shipping, which no effort of the Explosives Department could avoid. But the Department diminished this strain by seeing that none of this acid was wasted and that as much as possible was recovered for future use. These duties were carried out faithfully and efficiently; plant for the recovery and concentration of the spent acid was installed in all factories, and, by a rigid system of inspection and the check kept on the amount of acid used in the different factories for each ton of explosive produced, many avenues of waste were discovered and closed.

Another method for decreasing the importation of acid was that of educating manufacturers and the public to use substitutes for the sulphuric acid they had formerly consumed. Thus it was shown that "nitre-cake," which is an impure form of sodium bisulphate left as a residue in the manufacture of nitric acid, could be used for many practical purposes to replace sulphuric acid. Not only was nearly 100,000 tons of sulphuric acid saved each year, but a useless residue, which the nitric-acid makers had paid to get rid of, was converted into a saleable article. Further savings were effected in regard to fertilisers, by using basic slag to replace partially ammonium sulphate (which was needed for conversion into ammonium nitrate) and "superphosphates," whose preparation involved the use of a large amount of sulphuric acid. Owing to the importance of preserving the proper distribution of sulphuric acid

between these two vital necessities—explosives and fertilisers—the control of the latter was placed under the Explosives Supply Department.

The importance of glycerine as a constituent of cordite has already been mentioned. This substance is usually obtained as a by-product in soap making, or manufactured from whale oil. As early as 1915 steps were taken to restrict as far as possible its use in trade, and also to increase the output. But again the demands of food and explosives came into opposition, and the increased output in this country could not be realised owing to the restrictions on the amount of oil allowed for soap making. Considerable help was obtained from the Colonies, who established factories to separate the glycerine from the vegetable oils they produced so that only the former had to be shipped. The importance of glycerine for explosives manufacture led to the whole control of oils and fats being vested in a branch of the Department.

Much of the cotton used for making gun-cotton had to be imported, but the Department were able to effect a great saving in this respect by making arrangements to increase the output of bleached cotton-waste from British factories. By these means the pre-war output of 70 tons per week was raised to more than ten times that amount.

Another substance which became of critical importance was acetone, without which cordite could not be made. Acetone is a by-product of charcoal making, and there was consequently only a very small manu-

facture in this country. The great source was the forest districts of America, but this market was soon flooded by orders from competing cordite firms which rendered the price very unstable. The difficulty was diminished by joint arrangements for purchase between the companies concerned, but it soon appeared that the total amount available would be insufficient.

To meet this deficiency the establishment of new factories both here and abroad was aided by the Department, who at the same time sought other means of manufacture. It was known that certain bacteria were capable of producing acetone directly by fermentation. Several distilleries in this country were accordingly converted into factories for producing acetone from maize, but finally this method was abandoned, as 20 tons of maize had to be imported for each ton of acetone produced. In Canada, however, large amounts were made by this process.

The shortage of acetone was accentuated by the competition of the Air Service, who needed it for the preparation of the "dope" with which the wings of the aeroplanes were covered. As it was clear that there would not be enough acetone for all, the decision was made to substitute cordite R.D.B., which could be made without its use, for cordite M.D.

It is rather a curious instance of the revenge of fate that this whole difficulty arose from the efforts of the British Government in the last century to avoid paying royalty to Nobel, who invented the propellant formed by the mixture of nitro-glycerine and gun-

cotton. The gun-cotton chosen by Nobel was one soluble in ether, and was defined as such in his patent, and had this been adopted the acetone crisis would not have arisen. But to avoid using his patented mixture, the Government deliberately sought and found another mixture in which a form of gun-cotton was used which was not soluble in ether, but only in acetone. In this way they saved payment of royalty on the comparatively small amount of cordite manufactured during the life of Nobel's patent, but this saving must have been swallowed up many times over by the large amounts paid for acetone during the war.

In the manufacture of the new cordite acetone was replaced by a mixture of ether and alcohol. Of course the facilities for the production of alcohol in this country were far greater than in the case of acetone, though in the past the greater bulk of the spirit had been produced for potable and not for industrial purpose. An appeal from the Propellant Branch of the Department, combined with a proposal for an equitable system of payment, led to the distillers diverting a large amount of their production to industrial uses, and no real difficulty would have been experienced as to the supply of alcohol had they been able to obtain the grain and molasses which they needed. But here again shipping difficulties came in, and it became necessary first to limit and then to forbid the manufacture of spirit for drinking purposes, and to restrict as far as possible its use in industry and for

munitions. It was, however, not found necessary to take for munitions the spirit already maturing in bond.

The need for alcohol affected so many Departments that the control in this case was not put under the Explosives Supply Department.

Besides its use in connection with propellants, very large quantities of alcohol were used together with benzol in purifying T.N.T. The expenditure for this purpose was minimised by reducing the amount of purification wherever possible.

So far I have spoken of the supply of raw materials ; there remained the question of manufacture. In November 1914 there were only three firms in this country actually manufacturing T.N.T., and though others showed a willingness to accept orders, it was generally with reservations that rendered the date of delivery very uncertain.

Lord Moulton's first review of the position was typical of his subsequent actions. He gave his first estimate of the monthly requirement in the near future as 14,000 tons of high explosives, which was five times that needed at the moment and many times the amount for the supply of which provision had been made. He also saw that, in view of the double pressure of the immediate demand and future probable expansion, a double plan of development must be adopted. Firstly, to encourage all possible contractors, whether or not they were on the official list, to take such part as was in their power in the production of high explo-

sives, and, secondly, to start national factories on an adequate scale.

Complaint has often been made of the delay in Government Departments, but if the History of the Explosives Department is ever published, I think it will be noticed that in this respect at least there was little cause for reproach. A.6 was formed on January 1st, 1915, and on January 8th construction work was begun on a factory at Oldbury, part of which, the mono-nitro-toluene plant, was in working order at the end of May, and the factory was completed and producing 200 tons per week by mid-July. Nine weeks saw the transfer of a plant for distilling Borneo petroleum from Rotterdam to its English site.

The erection of these factories and of many subsequent ones was largely in the hands of Mr. K. B. Quinan of the Cape Explosives Company, who had been called from Africa in December and arrived here in January. Mr. Quinan's almost unique knowledge of chemical engineering as applied to explosive works was used by Lord Moulton to the utmost possible extent.

These early factories were followed by a series of others on a continually increasing scale, the biggest being at Gretna, Queen's Ferry, and Oldbury.

I speak of "factories," but the word seems an inadequate description of what some of these huge installations really were. We are not used to "factories" to walk round whose outskirts would be a full day's march—twenty miles—or whose erection

included, as a minor but necessary part of the work, the construction of two townships on the most modern lines where the workers might live. And owing to the desolate spot chosen the installation was necessarily self-contained, since no electric, gas, or even water-works existed in the neighbourhood. And all this had to be erected with the maximum speed and under the immense disadvantages of war-time work.

The development of supply through private contractors presented very many difficulties. Prior to the foundation of the Explosives Committee the War Office had shown great reluctance to depart from the system of finance that it had been able to enforce during peace. Contracts were rejected because the contractor wished to protect himself against a rise in prices, and would not give a tender in the form that was usual. Further, it had always been the custom to ask for tenders for a finished explosive according to the specification then in force, and the War Office saw no reason to depart from this practice. My father, on the other hand, felt that the best way of procuring that which he wished to have was to meet every serious requirement of the contractor as far as possible. He saw that the contractor's fear of a rise in the price of raw materials was a well-founded one, and departing from the official view that this was a risk which the contractor should take, decided that the best, and in the end the cheapest, method was for the Government to take the risk itself.

The plan that he pursued from the first was to free the contractors as far as possible from outside risks, and then to ask (and usually to get) a fair business price named for the explosive. In the case of the installation of new plant the contractor was told that its cost might be written off at a liberal rate per ton, and that in the case of a sudden termination of the war he, Lord Moulton, would see the contractor was no loser, while the risks of a rise in the price of raw materials was met by a sliding-scale clause or the promise of delivery of these materials at fixed prices.

This of course refers to the early days when the full measure of control was not applied. Later, as the powers of the Department grew, a flat rate for all contractors was insisted on in most cases. This method of course was by no means ideal. If a flat rate were fixed for any product, it must be such as would allow a fair profit to the smaller contractors, which in fact left in some cases an undue profit to those larger works which could be run more economically.

One of the risks which the Government was rather chary of assuming was liability in case of explosion, with its vast possibilities of damage to third parties. Lord Moulton realised that in the case of a widespread explosion the Government would have to pay compensation to those injured, and thought it better that they should explicitly relieve the contractors of the risk, and incidentally obtain their explosives

cheaper. The matter was brought to a head by an explosion which actually occurred, when unfavourable comment was roused by the delay in paying compensation owing to the contractors and the State disputing liability. At the end of 1916 an Act was passed giving the Munitions Ministry power to assume liability for explosions, and to charge contractors with premiums for a fair part of the risk.

By these means the Department were able to effect a considerable reduction in the prices of explosives in general in spite of the rise of costs. Another factor which greatly assisted in this was the establishment of the national factories, which not only relieved the Department from their dependence on the private contractor, but gave them first-hand knowledge of the cost of production and so enabled them to fix fair but not excessive prices.

It is difficult to overestimate the advantage that this early establishment of national factories proved. One of the first benefits was that they acted as a training-ground for the chemists and other members of the staff who were necessary for the later large-scale production. There were a number of highly skilled chemists available, but very few had had any experience of explosive manufacture. These men were put in the first factories, and as they acquired the necessary experience were drafted off to the new factories that were continually coming into being. In 1915 one hundred and fifty chemists were withdrawn from military service for this purpose.

In these factories, too, new machinery could be installed and new processes tried out with much greater freedom and to much greater advantage than in private works, where there was sometimes a feeling of resentment at too frequent inspection, and a reluctance to disclose all the minutiae of manufacture for fear that trade rivals might be benefited. A uniform system of costing could also be adopted which enabled the advantages of different methods to be accurately ascertained. In this way progress was made during the few years of the war which probably would not have been attained during many decades under the normal system of trade jealousy.

But undoubtedly the greatest advantage was in actual saving of cost, the full amount of which is necessarily undeterminable. Had the Government been restricted to purchase on the open market for the supply of articles where the demand had in some cases increased a thousandfold, it is impossible to estimate what the ultimate cost would have been. The powers of control which Parliament gave would not have affected this cost seriously, since only a comparatively small proportion of the extra output could have been produced from existing establishments in this country, and control could not extend beyond the realm.

I lay stress on this because comments have naturally been made since the war on the cost of construction of certain of these factories compared with their post-war value—or rather the prices obtained

by the methods which have been adopted for their disposal. It may therefore be of interest to state—as is the fact—that every one of the explosives factories far more than paid for itself on the most conservative method of estimation. It may be accepted that the private methods of production in this country were employed to the uttermost—the only alternatives were State manufacture or purchase from America. If the difference in prices between the lowest quotation from America and the cost of production in national factories be multiplied by the amount so produced, the whole cost of erection and installation of each factory would in every case be greatly exceeded. And it should be noted that the American quotations were for delivery at the manufacturers' works, so that all the cost of conveyance overseas and all the losses in transit would have had to be borne by the British Government. Further, these quotations were made when it was known that the Government had national factories at their disposal, and were only contemplating purchase for the comparatively small excess desired as a margin of safety. What they would have been had the contractors known that our Authorities were absolutely dependent on overseas supplies must be left to the reader's own imagination.

The new factories also enabled greater precautions to be taken for the health of the workers and for their safety than was possible in the case of establishments built for other objects and hurriedly adapted



[Central News.]

LORD MOULTON ATTENDING H.M. THE KING AT QUEEN'S FERRY FACTORY.

to explosive manufacture. And a still greater advantage was that they could be placed in appropriate situations far from the haunts of men, and also generally where the genial Zeppelin would have the greatest difficulty in reaching them. The terrible effects of the Silvertown explosion—in a factory which had to be acquired for explosive manufacture in the early days when every risk had to be taken to get an immediate supply to the men in the field—shows how inappropriate an explosive factory is among a civilian population. The wilds of Wales or the comparatively unpopulated spaces of the border were the spots that appealed to my father as most suitable for his work.

The King on several occasions visited these factories, and throughout took the greatest interest in Lord Moulton's work and discussed his new processes and programmes with him in detail.

The establishment of national factories enabled the safety precautions to be taken on the most complete scale possible, though such precautions were also strictly enforced at most private factories. These precautions included stringent regulations against taking matches or any form of smoking materials—even loose tobacco—into the "danger zone." Infractions of these regulations were punishable by fine and imprisonment, and many prosecutions had to be undertaken. It was always a source of wonder to the Director-General that although the offences which led to these precautions involved the

greatest danger to the lives of the offenders' co-workers, their sympathy always seemed to be for the person caught, and it was a common practice to have a whip round for the payment of fines inflicted for smoking, etc., amongst those who would have been the first victims of any accident caused by the delinquent's carelessness.

My father was the witness of one very curious incident in the danger zone, not indeed of one of his own factories, but of one of the national shell-filling factories which he was visiting in company with its director. A workman announced the arrival in the factory of a large railway truck, and asked for directions as to its disposal. As no such truck was expected the head of the factory went to look at it, and ordered it to be opened so that its contents might be ascertained. To the horror of everyone it was found to contain ten tons of gunpowder—of course anathema where high explosive is present, as the least spark ignites it. Everybody present, from the Director-General downwards, assisted to get that truck out of the factory in the least possible time, and when this was done, investigations as to how it had come there were set on foot. Every indication of its origin had, however, been removed, and I believe that to this day the cause of its arrival remains a mystery, though there was a strong suspicion that it had been sent by no friendly hands.

Very considerable improvements were also made in the process of manufacture. At the beginning of the

war a ton of toluene (representing 600 tons of coal) only gave from $1\frac{1}{2}$ to $1\frac{3}{4}$ tons of T.N.T., while at the end at least 2 tons were obtained. The saving in acids was even more important, since at first 6 tons of sulphuric acid was needed to produce a ton of T.N.T. (including the sulphuric acid used in the manufacture of the necessary nitric acid), while at the end less than one-third of this amount was used. A continuous process for the production of T.N.T. was also adopted which increased the capacity of works fivefold.

Another change in the direction of economy introduced by Lord Moulton related to the purification of T.N.T. The original War Office standard of purity was very high—far higher than was in his opinion necessary under actual conditions. This high standard was partly a legacy from the days when lyddite was employed, since with lyddite the slightest trace of metallic impurity might precipitate an explosion, and was partly dictated by considerations relating to long storage which had no force when the guns were eating ammunition as fast as it was produced.

The purification of T.N.T. to this extreme point had three disadvantages. Firstly, the special plant and great skill required limited the number of manufacturers who could make T.N.T.; secondly, the process (distillation in alcohol or benzol) was very dangerous, and especially objectionable in works where large-scale manufacture of explosives was in progress; and, thirdly, the removal of the last traces of impurities involved washing away much T.N.T.

Lord Moulton met the first two difficulties by accepting crude T.N.T. from the manufacturers and purifying it at special works, but he went further and, in the face of much opposition, secured recognition of different grades of T.N.T., so that the most refined quality was only required for special purposes, such as ammunition for use in the Navy or tropical countries. This point might at first sight seem a small one, but it enabled the manufacture of explosives to be increased by many thousands of tons per annum.

CHAPTER VIII

REAPING THE HARVEST

TOWARDS the end of 1917 a further and very formidable task was added to the multifarious duties of the Explosives Department. This was the responsibility for the production of poison gases, a branch of work especially distasteful to Lord Moulton, who hated the idea of the introduction of this inhuman weapon, though he quite realised the necessity of our using it against its introducers, and using it on a scale that would make them regret their departure from civilised modes of warfare.

There are reasons which prevent much being said about the classes of poison gases used, or of their method of production. When the control of its manufacture was transferred to the Explosives Supply Department, there were already a number of firms manufacturing different gases for the Government, and the contracts which had been made were not interfered with, but a very large increase in the scale of output was desired, and it was arranged to devote some of the spare capacity of the explosive factories, more particularly of those which had been

designed for the production of picric acid, for this purpose, and a large-scale production of "mustard gas" by a process originally worked out by Messrs. Levinstein Ltd. was at once commenced. It may be said that nothing like the full output intended was ever reached owing to the sudden termination of hostilities. Had the war continued as expected through 1919, the enemy would have been treated to their own medicine on a scale which they could never have contemplated.

The production of these gases involved very many technical difficulties and required very special precautions for the preservation of the health of the workers. This was particularly so in the case of the manufacture of "mustard gas." One of the peculiarities of this "gas," which in fact is not a gas at all but a vapour or liquid, is that it is dangerous in far smaller concentrations than can be detected by the sense of smell. Further, if it gets on the boots or clothes and slowly evaporates it may seriously injure the wearer. Ventilation, cleanliness, changes of clothing, and the constant presence of doctors and nurses diminished but could not abolish these risks. On the other hand, these workers had one advantage—they were practically immune from the epidemic of influenza that was then raging; in fact in one factory where in other branches 50 per cent. of the hands went down with this scourge, only 3 per cent. of those engaged in the making of "mustard gas" were affected.

We thus find Lord Moulton during the later period of the war at the head of a Department which was not only responsible for the supply of explosives and poison gas for the whole of the British Forces, and for those large contributions of these munitions which we made to our various Allies, but had also control of the whole of the fat and oil supplies and of all the gas works and coke ovens, as well as of many other products and industries throughout the country. Even in these days of great Trusts there had never been such an accumulation of industries under one man—and this a man who when he was called to undertake this gigantic work was a judge of over seventy, whose whole professional life had been passed in the practice of the law, and who, in the popular sense of the words, had had no business experience whatever.

One hesitates whether to wonder more at the boldness or at the success of the experiment which placed such a man in such a position, and it will be well to consider what enabled Lord Moulton to succeed as he did.

In the first place, although Lord Moulton had had no business experience in the sense of himself managing a business, his work had during very many years brought and kept him in touch with a number of the biggest organisations in the country. His wonderful power of separating out and grasping the essentials, as opposed to the details, of any matter with which he had to deal, enabled him to acquire from these experiences that instinct and knowledge of the

principles of sound business conduct which in most cases is only acquired by a life spent in actual management.

His previous professional career also helped him greatly in another way. Very many of the big firms with whom he had to deal at the Department had been his clients, very many of the scientific experts had worked with him in legal cases. They came to him in his new capacity as to a man whom they knew, and to whom they were accustomed to speak with all freedom and confidence.

And they came also to a man with an established scientific reputation, to one who could converse in the shorthand which scientists use, and with whom discussion could be confined to the immediate practical details, since the first principles of the science were as familiar to him as to themselves.

He had also another valuable business quality—a remarkable power of rapid calculation. I do not mean that he would have rivalled a bank clerk in adding up long columns of pounds, shillings, and pence, but he had that much rarer faculty of almost unconsciously performing the processes which showed the actual effect of any figures given him on the final results of the manufacture to which they referred. These rapid mental calculations enabled him to detect instantaneously any attempts to overreach by a confusion of details or multiplicity of figures. I do not know if any of the class of contractors of whom one has heard who attempted to “ring the changes” on

innocent munition officials ever visited the head of the Explosives Department, but if so, they certainly did not repeat the experiment.

Further, my father had not only a great scientific knowledge ; he had, what is far more valuable, a real scientific instinct. He could detect the false note in a new scientific suggestion, and although he was willing and eager to listen to every new proposal that might help his work, he wasted little time over what was scientifically wrong. What was far more difficult was to judge the probabilities of immediate practical success of processes which were scientifically sound, but might develop unforeseen difficulties when worked on a commercial scale, and here too this instinct was usually successful. One instance may be given—his decision on the question as to whether we should devote our energies to the fixation of atmospheric nitrogen. He knew it was scientifically possible—more than that, that it was actually being done in Germany by a process which in theory had been published to the world. The temptation to obtain his nitrates from a source which the U-boats could not attack or foreign interference affect was very great, but his judgment told him that practical success could not be quickly achieved, and that the limited store of goods and labour in this country should not be drawn on for what would probably be ineffective during the war. This judgment was justified by results ; the process in question has since been the subject of long research, all of which has pointed to its ultimate

success and value to the industries of this country, but which has also demonstrated that it could never have been made effective before the end of 1918.

It should also be remembered that whilst my father had been interested in every form of scientific progress, his keenest interest had been for that branch of practical application termed Chemical Engineering. Those who have read his address to the Society of Chemical Industry, or to the Engineering Faculty at Sheffield, or his later lecture at University College on the training and functions of the Chemical Engineer, will realise how much thought he had devoted to the principles regulating the translation of chemical discoveries into industrial processes, and to the overwhelming importance of cheapness of production—in its true meaning of the utmost economy of labour.

There is another point of view which may be taken, and that is that in Lord Moulton's case the absence of any direct connection with trade was an advantage rather than a drawback. It is true that the "voice of the people"—as transmitted by the Press—continually urged the appointment of "business men" to positions of importance; but when this wish was complied with, and a man prominent in any industry was appointed to the control of that industry, the appointment was often followed by an ugly crop of rumours and small talk about favouritism and illicit preference, both among those engaged in the trade in question and the outside public. The fact that such rumours were in all probability without any

foundation does not nullify their ill effect in shaking public confidence at a time when every man's goodwill was needed, and, apart from this, they were a symptom of a state of distrust that would militate seriously against the success of the control set up.

The existence of such distrust in many cases was as undoubted as it was natural. No man really likes to make a father confessor of his rival in business, or to disclose to him either the difficulties under which he is labouring or the possibilities of development which he foresees. Such information is usually rightly kept within the walls of the office or board room, but when the State proposes to assume control of a business concern, or to make intimate financial provisions for its support and extension, such disclosures must be made, and made freely. Here the presence of a lawyer at the head of affairs was a real advantage. The legal profession in both branches in this country has built up a well-founded reputation for keeping its clients' secrets, and every business man has of necessity accustomed himself to speak with all confidence to his solicitor or counsel. Moreover, as has been pointed out, very many of the firms working with the Department had already known and worked with Lord Moulton in the trusted position of legal adviser.

Probably every factory in the country has some private recipes or methods of working, but the importance attached to their preservation varies greatly in different branches of manufacture. There

is no industry where the tradition of secrecy has greater influence than in the explosive trade, both here and abroad. Working so largely for armament purposes, concealment had become as essential for themselves as for the military and naval authorities to whom their goods were supplied. It was therefore particularly difficult to persuade such firms to disclose their special methods of working, and to share with others those perfections of technique which they had themselves elaborated. Had the man who sought such information been a trade rival, the task would have been far harder. But with Lord Moulton they could at least discuss these questions with absolute safety to themselves, and, further, they were sure that the motive which was behind the request to place their knowledge at the country's disposal was an absolutely pure one, free from any possible taint of a desire for personal profit from the knowledge so acquired. In this way my father was able, though in some cases not without great difficulty, to persuade the more experienced firms to place at his disposal those details of practical working which were so necessary to ensure the success of the new-comers to the trade.

It is even possible that absence of actual business experience may have helped Lord Moulton at the first in another way. What was wanted was largeness of view and boldness of conception, and perhaps a too intimate acquaintance with detail difficulties might have hampered these. One of my father's favourite

proverbs was that as to the difficulty of seeing the forest because of the trees, and certainly what was then wanted was a man who would not bother too much about small practical difficulties, but would lay the right course and be confident that he and his helpers would remove any obstacles that might appear in it.

In addition to these qualities my father had a great power of working with others, and a singularly tactful management of delicate negotiations. This was peculiarly necessary in his position, since his dealings extended considerably beyond this country into regions where the powers given by the Defence of the Realm Act did not run. In particular he sustained the most intimate and friendly relations with the corresponding Departments of the Allied Countries, a by no means easy task when they were all hankering after the raw materials so necessary for their work.

One of the greatest difficulties in Lord Moulton's work was the continual variation in the demands made upon him. His position resembled that of the Director of Finance under Louis XIV, whom the King called on for such sums as he might desire at the moment, quite irrespective of the amount there might be in the Treasury, or the possible resources for replenishing it. The sole test of the efficiency of the Director of Finance was whether the sums called for were produced; so too the Director-General of Explosives Services was expected to fulfil the programme of the moment, based on the naval and

military needs, however great the demand might be upon him. Such variations were no doubt inevitable in such a war, and no complaint was ever made by Lord Moulton on this score, but these matters must be borne in mind in estimating the full value of his work.

So far as was possible a programme was fixed for each year, but the actual demands fluctuated continually. A victory or defeat, the entry of a new ally into the field or the virtual disappearance of an old one—all these might render past calculations useless. Apart from these causes, strategical or tactical changes based on the lessons learnt in the field might entirely vary the amount or nature of the demands.

These fluctuations were not always in one direction, and often preparations which had taken months or years proved useless owing to factors outside the control of the Department. For example, the new processes for the production of picric acid and the factories built to exploit them were abandoned when the military authorities became convinced that amatol—which was cheaper and easier to produce—was as efficient as lyddite. Again, the exigencies of shipping space, coupled with those of finance, might force a curtailment of the production of explosives, or a change to those least dependent on the importation of materials, while the effect of the conflicting claims of food and ammunition have already been mentioned.

One matter which undoubtedly added considerably to the great strain on Lord Moulton throughout those

four years was the anxiety inseparable from the lives of those who deal with explosives. No head of a Department throughout the war could escape anxiety—there was always before him the risk of trouble with labour, shortage of materials, or failure of plant. But at any rate he had a fair expectation that his works would remain, and that any difficulty would be of reasonable dimensions and of short duration. It was very different in the case of Lord Moulton. At any time a moment's carelessness by a workman or some quite unforeseeable and unpreventable reaction of the violent and uncontrollable materials with which he worked might utterly destroy a whole factory with its hundreds or thousands of workers. And the consequences of the disaster might not be limited to them, and might spread far and wide among the civil population around.

Unfortunately these fears were at intervals justified, and several terrible explosions did occur; though, looking back to the huge expansion of the explosives industry during the war and remembering that this had to be carried out with workers who for the most part were entirely new to the trade and in many cases in factories built for other purposes, it will probably be felt that the disasters were fewer than could have been reasonably expected. This made them none the less terrible when they occurred, nor did it prevent the sympathy of the public for the victims from suggesting in some cases that they might have been avoided.

I think that perhaps my father's innate common sense enabled him to stand this strain better than some others might have done. His lively sympathy for the victims did not drive him into any undue self-condemnation. He knew that every precaution that it had been possible for him to take had been taken, and he did not uselessly speculate on how a disaster might have been prevented had some other course been taken, which in fact would not have been possible without unduly hampering his main work or which would not have presented itself as more favourable on the materials on which he had had to form his judgment.

But I think it was the knowledge of these very special risks which made him so insistent on secrecy as to all his Department's work. He could not bear to risk that some apparently harmless and justifiable remark on the activities of a certain factory might draw enemy attention and provoke an attack on it and on those who worked there. And he also realised how much greater and more terrible the consequences of such an attack would be in places where the direct effect of falling bombs was nothing compared with that of the explosives that they might set in action. So again any indication of the programme for explosive production might lead an intelligent enemy to concentrate more on the route of those ships that would bring the essential materials for the completion of the programme.

The strain involved by this work would have

broken most men of whatever age, but, during the war at least, Lord Moulton showed no sign of being affected. This was the more remarkable since throughout his life, even at the busiest times of his legal career, he had taken full and regular holidays.

His physical activity was marvellous for a man of his age. The story is told of his arrival at Storey's Gate, where at 9 a.m. a queue of the younger employees of both sexes were waiting for the somewhat small lift to make the necessary number of journeys to take them to their respective floors. This queue was suddenly broken through by their seventy-year-old chief, who came in, and according to his usual habit proceeded to run up the stairs (he never walked upstairs) to his offices on the top floor. It is said that that queue never re-formed—either on that morning or on any other.

His day's work at the office commenced at 9 a.m. and continued till 6.30 or 7 p.m. More often than not he would have some of the officials or contractors to dinner, and prolong the day's work till 11 or 12 at night. This would be the routine from Monday to Friday, when he would go off for equally strenuous work at inspection of his factories. And this went on for four years, during which he did not take ten days' holiday.

In the summer of 1916 he paid a flying visit of a week to France, in which time he visited the principal explosives works, with the object of ensuring better co-operation, and also of sharing any technical

improvements which either country might have made. As these works were largely in the Pyrenees and other of the remoter parts of the country, the visit proved anything but a holiday. I remember being told by one of the French officers who accompanied him that my father's programme of what could be covered in a day's inspection not only astonished his guides, but left them in a state of complete exhaustion by the evening, while it only seemed to increase their guest's appetite for his dinner, and his readiness to prolong far into the night the technical discussion which followed.

In many ways he differed from the popular conception of departmental and munition autocrats. At a time when whole fleets of motor-cars were placed at the disposal of those in authority, he could never be induced to apply for one for his own use. His journeys to his factories were made on his own car, and on the very limited amount of petrol allowed to the general public. To save this for his week-end inspections he travelled by underground even during the times of greatest crush.

His offices were on the top floor of the Institute of Mechanical Engineers in Storey's Gate, which were kindly placed at his disposal in December 1915. This kindness was repaid (to use his own expression) by "cuckoo-like" ingratitude, as his growing staff soon entirely ejected the legitimate occupants, and overflowed into many of the surrounding buildings.

It was of course impossible to carry out the multi-



ON INSPECTION DUTY.

Lord Moulton with his Daughter-in-Law, the Hon. Mrs. Fletcher Moulton.

furious duties of the Department without a large number of workers, but Lord Moulton took every means to prevent this number from attaining undue proportions, and the various efforts that were made to "comb out" unnecessary office workers left the Explosives Department untouched—as none were found there. He was particularly anxious that his Department should not shelter those who might be in the fighting line, unless they had such special technical qualifications that the public interest really demanded their retention.

In spite of the magnitude of his task, Lord Moulton contrived to be singularly accessible to those doing business with the Department. The facts brought out in the "Halakite" case show the personal attention he gave to anyone with a proposal that might by any possibility prove useful. In fact, his tendency was wherever possible to arrange matters by personal interview and to cut out as many links as possible from the official chain.

Consequently he never took kindly to the traditional system of official correspondence—and often spoke of it in a way that would have caused sorrow to those who had devoted themselves to the elaboration of its routine. He sometimes amused himself by re-reading some of the more glaring instances of the amount of work which could be devoted to the most trivial matters. I give here one of his favourite examples—it is a copy of an actual file, only the names of officials being omitted—as I do not think

that at this period it divulges any information detrimental to this country's interest.

The file refers to the provision of rats which were used for certain purposes in factories dealing with poison gases. It is as follows :

D.E.O.S.

With reference to B.M.Q.M.G.7. 11683, 12 special rats were obtained for the Chemical Shell Store, and authority is now requested please for an expenditure of 3*d.* per week per rat for maintenance, as besides being kept alive they must always be in good condition to satisfactorily serve the purpose for which they were provided.

(Sd.)

For D.D.O.S., W.A.

8.1.1918.

Q.M.G.F.a.

Any remarks ?

(Sd.)

For A.D.E.O.S.

Q.M.G.7.c.

16.1.

Q.M.G.7.c. (through Q.M.G.6.) Seen. 18/1/18.

No objection to necessary expenditure within 3*d.* a week a rat. We have no information as to cost, but should have thought it might be less.

(Sd.)

Q.M.G.F.a.

17.1.

D.D.O.S.

Expenditure up to 3*d.* per week per rat approved.

You will no doubt take steps to see that the establishment is not unduly increased.

(Sd.)

For D.E.O.S.

Q.M.G.7c.

19.2.18.

D.E.O.S.

Noted. 12 rats were originally purchased, but the stock shortly increased to 34, of which 6 were sent to a Trench Warfare Filling Factory and 3 destroyed, leaving a total of 25.

In view of the Chemical Shell Store at Gatwick shortly opening, it would be a pity to destroy these rats, as at least a dozen will be required for Gatwick.

It is therefore considered necessary to keep a stock of 30 rats at Woolwich and Gatwick, i.e. 18 Woolwich (including reserve of 6) and 12 at Gatwick. Any surplus above this number will be sold if possible, and profit credited to Rat Fund, or else destroyed.

Authority is requested for the above establishment to be maintained.

(Sd.)

For D.D.O.S.,

Woolwich Arsenal.

15.2.1918.

Q.M.G.F.a.

Recd. 26s.

Q.M.G.F.b.

Subject to your concurrence it is proposed to authorise what D.D.O.S. proposes. Concur?

(Sd.)

D.A.D.E.O.S.

Q.M.G.7.c.

19.1.18.

Q.M.G.7.c.

We have no objection. No doubt care will be taken to avoid any unnecessary expenditure on food where the rats could be fed on stale bread, etc., which might otherwise be thrown away.

(Sd.)

Q.M.G.F.a.

12.2.

D.D.O.S.

Please see.

(Sd.)

D.A.D.E.O.S.

D.E.O.S.

Noted.

(Sd.)

For D.D.O.S.

28.2

Q.M.G.7.

With reference to your B.M. 11/683/1916, would you kindly authorise the issue of an allowance of 1/6 per week for the upkeep of rats at A.O.D Depot, Banbury, where the storage of chemical shell will shortly commence.

(Sd.)

S.D.O.S., F.F.a.

ADASTRAL HOUSE,
31st May 1918.

A.D.O.S.F.F.A.

In view of your previous experience as recorded

in Min.11, can you roughly say how many rats you want ?

(Sd.)
D.A.D.E.O.S.

Q.M.G.7.c.
1.6.18.

Q.M.G.7.c.

We hope to be able to make six suffice, and it was on this number that the amount of the allowance for which we requested authority, vide minute 16, was based.

(Sd.)
A.D.O.S.F.F.A.

ADASTRAL HOUSE,
LONDON, E.C.4.
3rd June 1918.

F.8.

Any remarks ?

(Sd.)
D.A.D.E.O.S.

Q.M.G.7.c.
5.6.18.

Q.M.G.7.c.

No financial objection provided it is clearly understood that 3*d.* per rat per week is the maximum within which expenditure is allowed.

(Sd.)

Q.M.G.F.
18rd June 1918.

A.D.O.S. (F.F.A.).

3*d.* per rat per week is approved for six rats

or such other number as you may consider necessary.

(Sd.)

D.A.D.E.O.S.

Q.M.G.7.c.

20.6.18.

Q.M.G.7.c.

Noted. We are preparing to store gas shell at Hereford and have authorised the O.O. there to draw a similar allowance under this authority for not more than six rats.

(Sd.)

For A.D.O.S. (F.F.A.)

22nd June 1918.

The very success of Lord Moulton's Department kept it largely out of the limelight. Although it experienced many times of stress, it was always able to keep ahead of the demands on it, and consequently there were no crises to draw the attention of the Press.

There was, however, one exception which led for a time to the Department being exposed to very unfavourable criticism. As my father himself was very intimately concerned in this matter, and as for some reason considerably more attention was paid by the Press to the charges made than to their subsequent refutation, it may be well to retell the story which in itself is one of considerable interest.

In June 1915 a new explosive known as "XXX," "Rexite," or "Halakite," was offered to Lord Moulton, who had it tested and decided that it was

not expedient to adopt it. The persons interested, however, continued to press this explosive both on the British and Allied Governments. Towards the end of the year Sir Theodore Cook, the editor of *The Field*, became associated with its sponsors, and the campaign for its adoption was pressed forward most vigorously. Later a licence to a syndicate to manufacture and trade in it was applied for and refused, and subsequently the Intelligence Department, acting on information which they had received, refused to permit the inventor, a Mr. Blanch, to go to France, where he had been offering the explosive to the French and Russian Governments.

About this time Sir Theodore Cook, who undoubtedly believed in the great advantages that "Halakite" was supposed to possess, wrote a series of letters to Cabinet Ministers and prominent officials stating that the refusal of the British authorities to permit the adoption or manufacture of "Halakite" was inflicting great injury on this country and its Allies. Some of these letters contained somewhat grave charges against other officials, but all that was imputed to Lord Moulton and his Department was that degree of stupid conservatism which according to the belief of certain sections of the Press is the natural quality of Government officials. In many cases these letters led to appeals to Lord Moulton, from persons to whose opinion he attached the greatest weight, to give further consideration to this wonderful new invention. In consequence of these appeals

Lord Moulton, who throughout believed in Sir Theodore Cook's honesty, had the further interview with him which will be referred to later, but refused to alter his decision or to attempt to get the proprietors of the invention any facilities for its exploitation until the requests he then made had been complied with. These proprietors, the White Power Syndicate, then decided to dispense with the official licence which was necessary for all who were trading or attempting to trade in munitions of war, and continued their correspondence with the representatives of foreign Governments.

The result was that on January 15th, 1917, officers, acting on a search warrant issued under the Defence of the Realm Regulations, made a raid upon Sir Theodore Cook's room at the offices of *The Field*, from which most of the correspondence had been conducted, and seized certain papers. This set the Press ablaze. Sir Theodore Cook was personally very popular, his views of his grievances and of the stupid opposition he had experienced had been spread broadcast, and above all an editor's sanctum had been entered. Further, Government officials have few friends.

This feeling was reflected in Parliament, where many advocates were found for these patriotic Englishmen whose efforts for the Allied cause had been so continually thwarted, and who had been exposed to these insults as a reward for their attempts to repair the effects of official obstinacy and prejudice.

As a result of this the Government ordered a full inquiry to be held.

There is no doubt that popular opinion was at this time on the side of Sir Theodore Cook and the White Power Syndicate, and murmurs were heard in many quarters that "Moulton would have to go" as a result of the revelations that would be made. Meanwhile Lord Moulton quietly continued his work at the Department, together with the additional tasks that the preparations for the inquiry threw on him.

After one or two preliminary meetings the effective business of the inquiry was opened on March 17th, 1917. It was held before Mr. Justice Shearman, with whom Sir William Pope was associated as Chemical Assessor. Lord Moulton and the public authorities concerned were represented by the Lord Chancellor and Lord Chief Justice, the late Mr. A. J. Walter, K.C., and Mr. (now Mr. Justice) Branson. Sir Arthur Colefax, K.C., led for the White Power Syndicate and its directors (including Sir Theodore Cook), and Mr. Ellis Griffiths, K.C., for Mr. Blanch, the inventor of "Halakite," whilst various other parties concerned were also represented.

The terms of reference were wide, and included an inquiry as to the refusal of the Explosives Department to use "Halakite," the refusal of the licence to the White Power Syndicate to trade in the same, and the circumstances of the raid at the offices of *The Field*. Sir Frederick Smith (now Lord Birkenhead) in his opening speech took the line, so effective when

the advocate is sure of his case, of first presenting in full the case made against him, and for this purpose gladly seized on the book that his enemy (for the nonce) had written. In the absence of formal pleadings he presented the case of his opponents as set forth in the letter of November 16th, written by Sir Theodore Cook to the Prime Minister (Mr. Asquith). In justice to Lord Moulton and the other officials concerned this letter should be set out as showing the charges which were made against them :

“ As a matter of urgency, and with very great respect, I venture to solicit your immediate personal attention to a question concerning munitions for our Allies, which has now reached a point where, to my profound regret, my unaided efforts will no longer avail to prevent a public scandal of the most serious nature.

“ I have had the honour to keep you informed, since the day (in June) when I joined my friend (that is, Mr. Blanch) in ownership, concerning the new material called Halakite. We do not for a moment complain that the British Government does not desire to use for our own Army a material that has been proved to be cheaper, safer, and more effective than any now employed. But it is no longer possible to remain silent when British officials prevent our Allies from using this material, after it has been successfully tested by the Russian field artillery (the results and figures are at your service), and after the Russian General Staff have thanked us for our efforts to supply them with it (in correspondence at

your disposal) some months ago. The result of the delay caused by British officials may be seen in Roumania to-day.

“ The French Government’s analysis (by Darzens & Vieille) and the correspondence with M. Thomas (which are Nos. 8, 9, 10, 11 of the dossier, and are enclosed for your information) prove the high value France also attaches to this material ; and as to the general advisability of assisting France with any new and satisfactory powder which would leave grease in the barrel instead of corroding acids, and would not call upon the usual raw materials for its manufacture, I will refer you to the records of the communications between the French Officials and Lord Kitchener on the subject of supplying our Allies with what they need.

“ The first delays were caused by Lieut. Somerset, of M.I.6.D. the War Office, who refused, on July 21, our application for a licence, and by Captain Stomm, of the International Commission in India House. Their conduct remains inexplicable. But we are ready to recognise that they are only subordinate officials who may have merely carried out orders ; and I desire to call attention to the attitude of Lord Moulton. He had rejected this powder on Feb. 4 (in spite of an earlier and favourable report from the Home Office) on the inaccurate analysis made for him by a Woolwich chemist, and on March 7 he had refused to safeguard the English patent, which was only saved by the intervention of the Admiralty. When he found the French Government’s chemist and the Russian field artillery test alike proved his own expert wrong, he refused us on September 5 the

usual licence even to correspond with Russia or France. On September 15, as if the differences in a chemical equation were the effect of dishonesty on our part, he asserted (without suggesting any proof) that the powder he had refused was different from the powder which France and Russia desire to have. He, therefore, demanded a fresh and lengthy test, though all the details he required were at the Home Office and in the documents enclosed herewith, and must have been within his knowledge before the end of May at latest.

“As the only Halakite in this country was then and is now in Lord Moulton’s own possession, the inventor went to France, whence he proposed to send a further supply to Lord Moulton for the requested re-examination. The inventor was thereupon (that is, Mr. Blanch) stopped at Southampton, stripped, and brutally treated, though he carried a letter from the French Embassy countersigned by our own Foreign Office.

“A previous attempt to arrest him in Paris, under false information provided by Captain Stomm, had been stopped by the officials of the French General Staff.

“There is no alternative left to the owners of Halakite, unless they receive the official assurance of the competent authorities that this line of conduct shall forthwith cease, but to expose the whole matter with documentary evidence in their possession and in the possession of the French and Russian General Staffs. They no longer take any interest in Halakite in this country, where it has been hitherto quite successfully turned down, but they consider that the

treatment they have received and the loss involved to the Allied cause are questions of public interest and safety which can no longer be concealed. The treatment meted out to the inventor has, it may be added, not only prevented the manufacture of Halakite in time of war in this country, but it has seriously delayed the development here of the kindred industry in dyes, which I had understood to be warmly advocated by the Government as one of the future industries of peace.

“ I have written thus freely and openly to our Prime Minister in time of war, as my last effort to prevent what I should consider to be the grievous disadvantage to the Government of a general knowledge here and abroad of what has been going on ; and you will, I feel sure, acquit me of any other motive for this letter. The owners of Halakite do not ask for any financial assistance or any favours from the British Government, they have indeed been only too desirous of following any advice you may yourself consider fair, having regard to the paramount interests of this country ; but they are bound to take steps that the persecution of their inventor and of his material in France, Russia, and elsewhere shall forthwith cease by one means or another, and if it should be made to cease, in the exercise of your discretion in this matter, by your general assurance that this American citizen of Italian birth (that is, of our Mr. Blanch) shall no longer be refused permission (under the ordinary safeguards) to correspond and to travel between France and England in order to complete the process of transferring his business across the Channel—I, for one, shall be profoundly grateful that you have

chosen a course so eminently advisable and just.

“I venture to beg an acknowledgment of this letter to be sent to the Oxford and Cambridge Club, in Pall Mall, and if there should be no change in the present position, I hold myself at your disposal for any information in my power at any time and place you may see fit to appoint before Tuesday, December 5, after which date I shall be powerless to prevent any further action.

“T. A. C.”

The following paragraphs from a letter to the Secretary for War (Lord Derby) should also be remembered :

“In 1914 an American citizen of Italian birth, whom we will call B, invented a chemical compound (as a by-product of dyes) hereafter referred to as XXX. The records of the chemical analysis and practical tests to which it has been subjected by the best authorities are on record. They prove (a) that as a smokeless propellant for Field Artillery it produced all the results of the usual propellants (namely, a recorded result of a mean muzzle velocity of 585 metres per second with a pressure of 2,500 kilos per square centimetre) with less material, and that instead of having a corrosive effect on gun barrels it leaves a trace of grease which prolongs its usefulness ; (b) as a high explosive (non-smokeless) it is very much stronger than nitro-glycerine or picric acid ; (c) in either of its forms it can be modified to suit the various military uses for which it may be required ;

(d) it does not call in the usual way upon the raw materials (acids) employed in bulk for other explosives ; a valuable point when it is considered that the more varied the stock of suitable powders, the easier it is to keep it at a constant level of intensive production ; (e) its stability is extraordinary and it can only be exploded by the electric spark or by the ordinary detonator in use in the Allied Armies.

“ To the best of my knowledge and belief, it therefore appears likely to give better results in several directions at a less cost than any powder now used, and I mention this first because the innate excellence of the powder itself seems to me to be by far the most essential point in any consideration of its use, and it is the point most easily and immediately proved. The Government officials in England, however, have concentrated all their efforts upon preventing the use of this material either here or in any other country, and upon putting every conceivable obstacle in the way of its owners. You may be interested to learn the facts concerning an official opposition for which no reason has ever been given.”

“ Halakite ” had first been presented to the Home Office with a request that it might be placed upon the list of authorised explosives, which was done. The Home Office of course only examine into the questions of safety in manufacture and transit, and their action had no effect on the war-time prohibition of manufacture and trading in explosives without a licence.¹

¹ The actual words of the Home Office certificate are : “ We are therefore of opinion that this explosive is sufficiently stable to warrant it being placed on the list of authorised explosives.”

The next step was its presentation to the Explosives Department. The invention was then the property of a company, Anglo-Explosives Limited, whose chairman, Mr. Wendell Jackson, described it as comprising two explosives—one (XX) a propellant, and a second (XXX) a high explosive. These were said to “belong to the class of safety explosives and to contain no nitro-glycerine, picric acid, nor other of the familiar explosives in common use.” The letter stated that the explosive was very stable, permanent, and safe, and could only be exploded by fulminates, that it was far more powerful than dynamite, and that all its ingredients were plentiful in England. Naturally such an explosive interested Lord Moulton extremely, and a request was sent for fuller particulars and the submission of a sample for test by the Government experts at Woolwich.

The results of these tests were surprising. The explosive which was said to contain no nitro-glycerine was found to contain 22 per cent. of this substance, as well as lead chromate—a strong yellow colouring matter. In spite too of the claims made for its great stability, tests showed that it was nearly twice as sensitive as picric acid, and therefore quite unsuitable for shell filling.

The attention of Mr. Blanch and Mr. Wendell Jackson was called to the presence of glycerine and lead chromate, but they both denied that either had been used.

Although Lord Moulton saw at once that the

explosive was unsuitable for gun ammunition, he suggested that it should be offered—with a more accurate description of its composition—to the Trench Warfare Department as a possible filling for hand grenades.

This was done, and “Halakite” was independently tested by this Department, who also rejected it as they found its explosive properties considerably weaker than those of ammonal.

In October 1915 negotiations were opened on behalf of the company (through a M. Vigoroux) with the French Government, considerable stress being laid on the certificate from the British Home Office authorities. In reply to a request for particulars of the new explosive an account substantially identical with that made to the Explosives Department in England was given, except that in this case it was stated that small quantities of glycerine and alcohol were among the constituents. Samples were submitted, with the result that after testing them the French Explosives Committee on December 20th, 1915, rejected the explosive.

Although the tests made by the various Departments had been so unsatisfactory, so little was it desired to handicap the inventors that on December 22nd, 1915, a licence was granted to Messrs. Blanch and Jackson to trade in their explosive.

In December 1915 and January 1916 further unfavourable reports were made by the Trench Warfare Department and communicated to Lord

Moulton. In consequence the Anglo-Explosives Company was informed that it would be useless to proceed with further trials of "Halakite."

The next step was a further attempt (through a M. Godot) to get the French Explosives Department to reconsider its refusal of "Halakite." With that object in view an amazing series of misrepresentations were made as to its use by the British Government. Two extracts may be given : " The explosive manufactured near London by the Anglo-Explosives Company, which is employed by the British Government for the filling of its shells, grenades, bombs, and for all engines of explosion, is a veritable phenomenon of science " ; and " The works of the Anglo-Explosives Company Limited are situated near London and cover an immense area of 250 acres, with all the necessary rail and water transport facilities. All these works are guarded by the military and are under the control of the Explosives Departments of the Home Office and the War Office." In fact, no "Halakite" or other explosive had been manufactured (except the samples for tests), and the company had no works whatever.¹ Even these statements, however, failed to move the French authorities, who replied that the whole matter had previously been examined and dismissed. This only stimulated M. Godot to further efforts, and in a subsequent letter he states :

¹ It should be noted that all the parties represented at the inquiry denied through their counsel that they had any knowledge of the mis-statements made to the French Government.

“ Finally, Monsieur, we insist more particularly on this point that ‘ Halakite ’ is no longer an invention, it is not a gamble, it has been made practical, put on a commercial basis a long time ago, and adopted by the British Government. Our Society is making of this substance 50 to 75 tons a day in its important factories situated near London.” In a subsequent statement he explained that the War Office would not permit him to disclose the locality of the works. He further stated that the Anglo-Explosives Company was ready to form a company in France with a capital of £1,000,000 and would manufacture 250 tons a day of “ Halakite,” and then added: “ The Anglo-Explosives Company delivers actually, and has done for a year, to the War Office from 1,500 and 1,800 tons a month and the deliveries increase every month.” This letter also contained a statement that “ Halakite ” contained 55 per cent. of nitro-glycerine and 35 per cent. of gun-cotton.

Apparently these negotiations were carried on under the popular assumption that Government departments like the French and British Explosives Departments were watertight compartments. In fact, the French authorities took the sensible course of applying to the British Department for a confirmation of certain of these statements, and promptly had the whole information which we possessed on the subject placed at their disposal.

In March 1916 Blanch and Jackson informed the French Government that in future they would

negotiate directly with it, and shortly afterwards submitted fresh samples of "Halakite." A test of these led to the French Government requiring that the manufacture should be carried out in the presence of Government experts and that the raw materials used should be stated. These requests of the French Government were never complied with.

In May 1916 an infraction of regulations led to the withdrawal of Mr. Wendell Jackson's licence. It was then proposed to form a new company to deal with "Halakite," and Sir Theodore Cook and others applied to the Treasury for permission to register the White Power Syndicate Limited. This permission was never given, and the Syndicate continued in its unincorporated form. On July 14th, 1916, a licence was applied for on behalf of the Syndicate to trade in explosives.

Shortly before this negotiations had been started with the representatives in this country of the Russian Government. They did not proceed far, as the first request of these representatives was for a full report of all tests of "Halakite" made by the British Explosives Department, and for a statement of the formulæ, etc., for submission to the authorities at Petrograd. One further step was, however, taken. As the Russian Commission were under the impression that "Halakite" was actually being manufactured in England, they asked to see the works, and a representative, accompanied by Major Stomm of the British Intelligence Department, visited these works,

which proved to be two disused candle factories which contained some nitrating pots. In fact, the Syndicate did not even own these, but only possessed an option over them. In October Mr. Blanch, the inventor and a member of the Syndicate, was informed by the Russian Commission that in view of the state of the Syndicate's works they did not consider they could proceed further.

In September the British authorities, in view of the application by the Syndicate for a licence to trade in explosives, asked the French Government if they had any use for "Halakite," and received a reply in the negative.

On September 5th, 1916, Sir Theodore Cook, who had previously had interviews with Lord Moulton in November and December 1915, was sent for by him. Lord Moulton explained to him that the samples of explosives submitted as "Halakite" differed completely both from the description of this substance which had been submitted to the Department, and from that contained in the Patent Specification. Sir Theodore Cook expressed surprise at this, and promised to investigate the matter. Lord Moulton stated at this interview, and in subsequent letters, that what he required was a statement (to be treated as confidential) of the true composition of "Halakite," and further that it should be manufactured in the presence of an expert and tested by him. Till the Department were satisfied in this manner they would not sanction the manufacture of the

explosive. Neither of these requirements was ever complied with.

Sir Frederick Smith then described the various samples and descriptions which had been given of the explosive. Starting with the statements in the specification and first description that the bulk consisted of nitrate of lead, and that it contained no nitro-glycerine, he traced its gradual development up to the last samples submitted to the French Government, which were identified as over 98 per cent. British Mark 1 cordite coloured yellow with lead chromate.

At this point of the Attorney-General's speech there came a dramatic interruption of a nature probably unique in legal annals. As the Attorney-General was proceeding to deal with the actions of the Syndicate which immediately led up to the raid, Mr. Colefax, K.C., rose and stated that in view of the facts set out by the Attorney-General his clients felt that they could make no complaint whatsoever as to the raid, and must admit that the authorities had been justified in their action in this respect. He further stated that he would like an opportunity of consulting his clients before taking any further part in the inquiry.

I doubt if there is any similar instance of an opening speech leading to the practical admission of the justice of the case so opened, even before any evidence has been called.

Lord Moulton was then formally called and gave

evidence (part of which was taken in private at the request of Mr. Blanch's counsel) as to his action in the matter. The Tribunal then adjourned for the day.

At the next sitting the counsel for the White Power Syndicate and its directors—other than Mr. Blanch—stated that in view of the fresh facts which had been brought to their knowledge in the course of the Attorney-General's speech, their clients wished to withdraw from the inquiry. Counsel concluded by making on their clients' behalf a full and complete apology not only to Lord Moulton, but to all other officials on whom imputations had been cast.

If the reader will take the trouble to turn back to Sir Theodore Cook's letter to the Prime Minister—with its tale of how our anxious Allies were being prevented by the interference of the British Explosives Department from getting the stores that they so much needed, its praises of the wonderful properties of the invention, and its fears of the terrible effect that it would have both here and abroad if the full story of British official interference were to become known—and compare it with the true story as given in the undisputed statement of the Attorney-General, he will realise how necessary this withdrawal was.

The only questions that remained were as to the *bona fides* of the inventor, Mr. Blanch, and as to whether he could in fact produce the wonderful explosive he had claimed.

At his request a chemist was sent to Paris to fetch

his apparatus, but failed to find it. A drawing of this apparatus showed, however, that it was of a simple character and could be easily procured here.

Formal evidence was given as to the substantial identity of "Halakite" with Mark 1 cordite, after which Mr. Blanch's counsel stated that he did not propose to put his client into the box or call evidence.

The final report of the Tribunal to the Army Council was issued on May 10th, 1917, and completely justified the actions not only of Lord Moulton, but of all other officials against whom charges had been made. In it was contained the report of Professor Pope, who found that the samples submitted consisted of cordite with the addition of other substances, and that as to the patent which was supposed to contain matter of such wonderful importance to the Allies, "the specification is the production of charlatans who seek to conceal the worthless nature of their invention by the use of a scientific terminology." The report ended with the following findings:

"The explosive substances submitted to the Munitions Department and to the Allied Governments under the name of Halakite were of no value.

"The refusal of the Department to use the same was justified.

"The refusal of the War Office to issue a licence to the White Power Syndicate to trade in explosives was justified.

"There is no foundation for any of the grievances or

complaints presented against any official of H.M. Government."

This was the end of the great "Halakite scandal," and it may be thought that, in view of the conclusion of the case, not much harm was really caused by the mistaken action of those who called for the inquiry. But it must be remembered that the preparation of the case for the inquiry in the Government Departments involved meant a great amount of work and worry for a number of persons who were very fully occupied with work for the country and who should have been spared all possible causes for anxiety.¹ It is an instance of how much harm can be done by persons who, although acting in perfect good faith, attempt to interfere in technical matters which they do not understand.

Another reason for the public ignorance of the Department's work was Lord Moulton's own desire for secrecy. Secrecy during wartime was of course the general duty and practice of the whole Munitions Department, but there appeared at times to be a feeling that some matters must be known to the enemy organisation, and that there could therefore be no harm in disclosing them to the British public. This no doubt was a reflection of the general miscon-

¹ This consideration should not be confined to the Government officials; it extended also to many of the legal persons engaged. In particular Mr. Walter, K.C., was, in addition to his practice, doing full work at the Munitions Inventions Department—a double strain that undoubtedly led to his break-down and sad death, while Sir Arthur Colefax was at the head of the Optical Glass Department.

ception then prevalent of the efficiency of the German Secret Service, which was supposed to have spies in every quarter and was considered by many sections of the Press and public to be infinitely superior to our own. Now that the veil has been partially raised on the workings of our espionage and counter-espionage departments, we know that the exact contrary was the case, and that the number of effective enemy spies in this country was very small; but I speak of the feeling that prevailed during the war itself.

My father never took this view. Like the older school of pleaders who never admitted any contention of their opponents, on the principle that its proof might be more difficult than appeared on the surface, he refused to assume that any fact about his Department was so certainly known to the enemy that to publish it could not assist them.¹

He was most reluctant that any particulars as to locality, size, or layout of any of his factories should ever appear in the Press, and was confirmed in this view by the fact that in spite of our superb intelligence work there were still many details of the enemy's corresponding organisation which we did not know. I remember that once on the occasion of the visit of a high personage to a large explosive works Lord Moulton was informed that it was desired that

¹ A good example of incidents which in fact were unknown, although this appeared to be very unlikely, is the landing of our Expeditionary Force in France. From captured papers it appears that the presence of this force at Mons was a complete surprise to the Germans, who thought it was still in course of embarkation.

arrangements should be made for a large number of press-photographers. Although Lord Moulton fully recognised the public motives that led to this desire, he at once said that such photographs might lead to the most undesirable results, and insisted that they should be confined to positions where he had satisfied himself that the background would reveal nothing which he wished to remain unseen.

This desire for secrecy was displayed in other directions, and he personally would have wished that nothing should ever be publicly spoken, in Parliament or elsewhere, about the Department's programme or performances. He recognised, however, that this was not practicable, and that the intense desire of the people of this country to know that in fact our soldiers and sailors were being provided with all the ammunition they needed must to some extent be satisfied. But he always urged that the information so given should be the absolute minimum necessary for the purpose, and that no desire to advertise the importance of the work that was being done should be allowed to add one iota to that minimum.

The position of those chosen for posts of responsibility during the war was peculiar in many ways, but in none more than in that of their control over expenditure. Having in fact power to spend sums running into millions, they were continually liable to have individual items queried by the Treasury and other officials, and to be compelled to embark on a long campaign of correspondence to obtain their

eventual allowance. The idea which would have prevailed in a private business, that if you could afford to trust to a man's control of vast interests you could afford to depend on his discretion in small matters, was entirely absent. Lord Moulton often chafed under these restrictions, and I remember him telling how on one occasion he asked a man of great technical knowledge to go to see one of his factories where some difficulties were arising, in order to give the Department the benefit of his advice and possible co-operation. The expert went without fee, but his fare—thirty-five shillings—was paid by the Department. This extravagance could not be passed by the Treasury; the man was acting without a fee, and therefore was not in the Government service, so how could his expenses be passed. Lord Moulton often said that this item of thirty-five shillings had given him more trouble than any other expenditure.

A subject in which Lord Moulton took the greatest interest was that of the health of his workers. Precautions were of course particularly necessary during the war owing to the great influx of persons whose upbringing had not accustomed and inured them to the discomforts incidental to factory life. In the case of explosive manufacture there were difficulties beyond the ordinary. Tri-nitro-toluene has very poisonous properties, and mere contact with it over long periods may lead to a break-down in health, though some workers seem quite immune. Strict personal cleanliness, complete change of working

clothes, and efficient ventilation were enforced in all his T.N.T. factories to combat these injurious effects. Milk was also provided for the workers, as this seemed greatly to diminish the effect of the poison. Care had also to be taken where nitro-glycerine was made or used, as this substance gives rise to the most violent forms of headaches.

Picric acid has also unpleasant though not dangerous effects. This acid is a well-known yellow dye, and in fact was used as such for over a century before any question of using it as an explosive arose. It acts freely on the human skin, and workers in picric acid factories became so coloured that they were nicknamed "Canaries." Luckily the effect wears off—though only slowly. My father often expressed his admiration of the spirit of the workers—especially the women—who were willing to sacrifice their appearance for their country's sake, and he was specially interested in any suggestions made as to possible means of preventing or removing this discoloration.

One interesting branch of the Department's work was that of finding safe stores for the immense amount of explosives it accumulated. This section was at first under the control of General Savile and later of Colonel Bridgman, who had the task of finding caves where thousands of tons of high explosive could be safely disposed. There were some towns whose subterranean deposits of explosives if roused to activity would have put the most violent volcano to

shame, but the sites were so chosen that no enemy bombing could possibly cause an explosion. The Department took its own measures for the guarding of these stores and for the guarding and policing of its factories, and so effectively was this done that it is believed that no single explosion was due to enemy action.

The Department was a happy one in its relations to labour. The direct connection of explosives with the naval and military campaigns drew to their manufacture a large proportion of those who came into munition work from a desire to help in the country's time of need, and their spirit spread throughout the factories. Also the special nature of the work to a large extent prevented disputes that arose as to the rates of wages for workers of particular classes spreading to it. Although trouble threatened at various times, there were no serious stoppages in the factories.

Here again Lord Moulton's personality assisted. He was continually visiting his factories, and I think the workmen got to know and appreciate his singleness of purpose, and to sympathise with his one desire—that whatever personal effort it might entail, the firing line should never lack ammunition.

One rather amusing dispute occurred at a factory which was very largely engaged in supplying the Department with raw materials. It was at a time when the call for men for the Army was most urgent and when every right-minded citizen who was kept

at home was anxious to wear the badge that showed he was working on Government munitions. Certain departmental purists had refused to grant the badge to the workers at this factory on the ground that, though it was very largely engaged on Government work, some materials were still being made there for private consumption. The men intimated that they wished to see Lord Moulton, who at once went down, when they delivered their ultimatum. Unless the badge was granted within twenty-four hours they would—not strike, that would have held them up to the contempt of every patriotic Briton—but *enlist in a body*. The men were skilled workers and knew they could not be easily replaced, and their departure would have cut off most necessary supplies. Lord Moulton returned to London and interviewed those purists—and the badges went down by the next train.¹

My father's relations with the contractors and manu-

¹ A somewhat similar incident occurred in Italy before the war. The railway employees were demanding an increase in wages, but as the railways were owned by the State, it would have been a serious offence to strike. The men therefore gave notice that unless their requests were granted, they would in future comply strictly with all the regulations. For example, since every stationmaster was by regulation responsible for the condition of each carriage leaving his station, he would in future do his duty by making a personal inspection of each carriage entering his station, before the train was allowed to leave. As there were many other regulations drawn up in the same spirit, the Italian authorities recognised that the railway system would be brought to an immediate standstill, but they equally recognised that it would be impossible to prosecute or punish their employees for obeying their own regulations. They therefore promptly arrived at a compromise with the men.

facturers from whom he drew his supplies were also exceedingly friendly. Although the Defence of the Realm Act and the various orders made under it gave him almost arbitrary power, his ordinary method was to act without recourse to them, and to strike a fair bargain with those who showed a willingness to act fairly. The very excellent spirit which prevailed between him and the private manufacturers was testified by the presentation made to him by the Society of Chemical Manufactures shortly before his death.

Lord Moulton's position of course involved responsibility for the whole of the proceedings of those under him, and for all that was done not only with regard to manufacture, but also in control of the industries that have been mentioned. But naturally in many of these branches the actual management would be left to their very able heads, though questions of policy would be decided in consultation with him. In regard to the manufacture of high explosives, however, he took a far more active part, and his position was much more that of the head of a business than the chief of a Government Department.

Here his supervision was of the most active kind, and his week-ends, as I have said, were almost invariably dedicated to inspection of his factories—a task rendered the more difficult by the isolated and inaccessible situations which he had chosen for many of them. He attached the greatest importance to these inspections, which not only enabled him to

detect where faults lay, but gave an opportunity of personal communication with those in direct control, which permitted him to anticipate difficulties or to repair them far more quickly and effectively than would have been possible had all reports been forced to pass through the ordinary tortuous channels beloved of officialdom. In this he was pursuing the method he had always adopted at the Bar, where he much preferred to get the views of experts and others who were assisting him by personal discussion rather than in the form of written proofs.

In these inspections he spared no physical effort, and would spend hours on end walking round the factories to see new machinery or talk with the workers, or running up ladders to get a more effective view where this might be necessary.

As this is a biography of Lord Moulton and not a history of the Explosives Supply Department, I have spoken of his work as a whole without attempting to show the parts played by those under him. The work he did could not of course have been accomplished without an exceedingly able staff—indeed it is the first proof of the ability of the head of a department that he should collect good men to work with him; he is responsible for their failures and can fairly claim credit for their success. All who knew Lord Moulton know how freely he gave credit for the success that his staff achieved, and had he been permitted to write the story of his department, there would have been little heard of him and much of

his helpers. I hesitate to mention any names, lest the exclusion of others should be wrongly held to indicate that Lord Moulton did not fully appreciate their services; but in addition to those already named, the services of Sir Keith Price as Deputy Director of Explosives Supplies and afterwards as member of the council dealing with the Explosives Services; of Sir Sothern Holland, who preceded Sir Keith Price as Deputy Director; of Colonel Corbett, who was Lord Moulton's first assistant and finally became Controller, and of Dr. R. C. Farmer, who was Lord Moulton's adviser and right-hand man on all chemical questions, cannot be passed over in silence. Lord Moulton's personal secretary, Mr. Achille Bazire, not only laboured throughout to spare his chief any avoidable work, but also did a large amount of most valuable liaison work with the French Explosives Department.

Of the chemists and scientists who outside his direct staff assisted him I name only one, Sir William Jackson Pope, but there were many others of whose services he often spoke.

Nor could his work have been so successfully accomplished without the whole-hearted co-operation of the manufacturers of explosives and chemicals from whom he drew his supplies, very many of whom devoted themselves to Government work at a very moderate rate of profit to the exclusion of the more remunerative private work which lay at hand.

Of all the men outside his Department with whom

Lord Moulton came in contact in the troublous times of 1914 and the early months of 1915 there was none for whom he had a greater admiration than for Lord Kitchener. Lord Moulton and Lord Kitchener had many attributes in common. Both were not only strenuous workers, but men of the most vivid imagination, and both had the faith that what to others seemed their wildest dreams might through earnest labour become realities. Both met the opposition and doubt that such imaginations must provoke, and neither could have attained the full measure of success without a similar helpmate.

I have indicated elsewhere how Lord Kitchener helped Lord Moulton to overcome the opposition that would, if successful, have so effectually limited his output. Possibly his sympathetic feeling was partially caused by the nature of the opposition he himself felt all around him. It is an open secret that there were many of the older school at the War Office who looked on Lord Kitchener's plans for the rapid creation of a huge new British Army as chimerical or—word of utter damnation—"unpractical." His lack of respect for traditional routine as the ruling factor in decisions earned for him among them the name of "Kitchener of Chaos." The name may have been justified, but it was from the chaos that he created that there sprang the British Army which changed the history of the world.

The most eloquent description of the total work done by Lord Moulton's Department is contained in

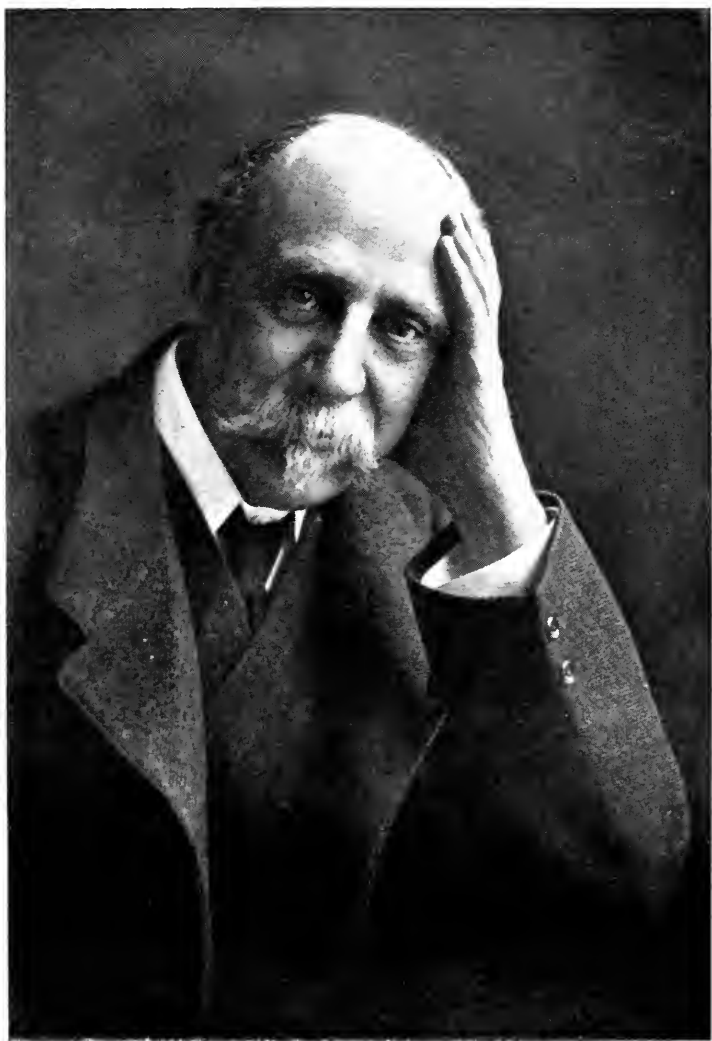
the actual figures of the explosives delivered by or through it. They are as follows :

DELIVERIES OF EXPLOSIVES, 1914-1918

(Short Tons)

	1914. August to December.	1915.	1916.	1917.	1918.	Total.
High Explosives (Picric Acid and T.N.T.) :						
Home .	434	9,822	58,420	94,785	79,098	242,599
Abroad .	nil	2,183	13,332	18,272	nil	33,787
Ammonium Nitrate :						
Home .	nil	7,101	51,158	135,355	124,011	317,625
Abroad .	nil	1,100	4,325	11,254	2,047	18,726
Total High Explosives	434	20,206	127,235	259,666	205,156	612,697
Propulsion Explosives (Cordite, Ballistite, and N.C.T.) :						
Home .	5,298	12,438	29,617	98,778	77,258	223,389
Abroad .	nil	13,535	54,594	106,031	52,938	227,098
Total Propulsion Explosives .	5,298,	25,973	84,211	204,809	130,196	450,487

A comparison of the earlier and later years shows how marvellous the increase in production was. In addition large quantities of poison gas were delivered in 1918, and production of this on a greatly enhanced scale commenced shortly before the Armistice.



Ernest K. Mills.

A LATE PORTRAIT.

Lord Moulton's services during the war were rewarded by the King, who graciously created him a Knight Commander of the Order of the Bath, and also gave him the Grand Cross of the Order of the British Empire. His services to the Allies were recognised by the bestowal of the Étoile Noire of France (Lord Moulton was already a Commander of the Legion of Honour), the Belgian Order of Leopold, and the Russian Order of the White Eagle. The last was conferred on him by the late Czar a few days before his abdication and was probably the last instance of its bestowal. The Czar's act was ratified by the Provisional Government and the Insignia duly delivered.

Lord Moulton's services to the country during the war were recorded by the Lord Chancellor in the House of Lords when the news of his death had been received. He said that he chose his words carefully when he stated that he greatly doubted whether it would have been possible for the war to be brought to a successful conclusion when it was but for Lord Moulton's part in it, and he hoped that the country would not soon forget the extraordinary services of this most remarkable man.

CHAPTER IX

AFTER THE WAR

THE end of the war did not see Lord Moulton's immediate return to the duties of a Law Lord. There were first many things to be done at the Explosives Supply Department, including arrangements for the disposal and utilisation of the huge surplus stocks, prepared as a reserve and in readiness for the 1919 campaign which up to a very recent time had been generally expected. Apart from the metal in the shells there were very large quantities of ammonium nitrate in their contents, and Lord Moulton had too great a regard for the value of combined nitrogen to contemplate with equanimity its loss to the world. Committees dealing with this question were formed, of one of which Lord Moulton was chairman, and eventually a large amount of this substance was separated from the T.N.T. and made available as a fertiliser.

But a far bigger matter was looming on the horizon. Throughout the war Lord Moulton had kept closely in touch with the dye manufacturers, who were struggling to supply the dyes which were absolutely essential to our textile trade, and which before the

war had been so largely purchased from Germany. The two biggest of these firms were Levinstein Ltd. of Manchester, and British Dyes Limited, a company which had been formed just before the war by the amalgamation of several firms, the most important of which was Read Holliday & Co. Ltd. The works of British Dyes Limited were at Huddersfield.¹ The lessons we had learned from Germany had shown that in dye-making combination is much preferable to competition. The numerous German firms had merged first into two groups and then into one huge pool—the *Interessen-Gemeinschaft*—which represented a capital at pre-war rates of over £60,000,000. There is no other chemical industry, except therapeutical manufacture, in which continuous research is so necessary, and the only method of avoiding duplication in this, and of utilising the results of the research to the full, is by large-scale combination. And the necessity of avoiding duplication extends also to the manufacturing branch. There are certain of the commoner dyes whose consumption is such as permits of their manufacture by competing houses on a scale sufficiently large to be profitable, but the demand of the trade for variety and new shades entails the

¹ In order to cope with the shortage of dyes, the Government had advanced considerable sums to this company to aid its further development. Among the conditions attached to this loan were provisions that until it should be paid off dividends should be limited to 5 per cent., that the prices charged for dyes should not be excessive, and that there should be an equitable distribution of these dyes without preference to particular customers. The Government had also the right to appoint two directors.

supply of many other dyes for which the demand is so small that the production for the whole country can best be carried out at one works. Lord Moulton in his last speech laid the emphasis on the contrast between German methods and our own in this respect :

“ They [the Germans] soon appreciated that the real competition of any chemical industry was not that of a next-door neighbour. The prize that the German manufacturer wanted to win was not that his goods should be preferred to those of his rival in his own country, it was that he and his rival should obtain command of the world’s markets, and the true competitors that he had to meet were those who out of Germany attempted to create a chemical industry.”

For these reasons Lord Moulton and many others wished to see a corresponding combination here. The two firms mentioned were not unwilling to entertain this idea, provided that satisfactory terms could be arranged. But clearly more than a mere combination of existing resources was necessary. When Peace came we anticipated a great demand for all those goods whose supply had been retarded during the four years of war—a far greater demand even than that which in fact came, since no one could anticipate that utter disorganisation of exchange which has so effectually prevented the countries whose needs are the greatest from coming into the market as buyers. To meet this expected demand

the existing resources needed to be supplemented by new capital in large quantities.

Lord Moulton's desire was that this capital should be provided as far as possible by the dye consumers.¹ He had no belief in, nor desire for, a lasting boycott of German goods merely because they were German, and he foresaw the tempting offers that would be made by our late foes to dye users here, offers in all probability of cheaper and even better dyes than we could hope to produce at the first. The best security for the new company's future trade would be that its potential customers were also interested as shareholders. Further, such a constitution of the company would ensure that its business would be carried on on lines acceptable to the textile industries.

But to Lord Moulton this was more than a peacetime question. The war had shown how every dye works was a potential explosive factory, and he considered that to leave these factories to our possible enemies was on a par with trusting to them for the supply of our battleships. This aspect, together with an earnest desire to keep this important branch of trade in our hands, induced the Government to take an unprecedented step in offering to subscribe £1,700,000 to the new company. Amongst the conditions attending on this offer were the right to nominate two directors, and also the issue to the Government of a single share which carried with it large powers of veto.

¹ This plan had already been adopted by British Dyes Limited.

Necessarily long negotiations were required before the scheme for the fusion of the old firms and the formation of the new company could be perfected. One of the main questions was that of the chairmanship, and it was fairly definitely intimated by those concerned that the only chairman that would be acceptable to all parties was Lord Moulton. This introduced a fresh difficulty : Lord Moulton was a judge, and it would be against all tradition for a judge to hold a commercial post. But the war had considerably shaken tradition in many directions, and the Government had given it a further blow by themselves assisting the finance of the company, and in the end it was arranged that Lord Moulton should be seconded for a year in order to enable him to serve as one of the Government directors, but on the strict condition that no extension of this period of absence from his judicial duties should be asked for. I may perhaps mention that this directorship carried no remuneration, nor in fact did he hold a share in the company, so that his views and actions in regard to our dye industry were free from the suspicion of any personal interest.

The year that was granted was in effect diminished by one-half by the time that elapsed before the issue could be made. On the formation of the company Lord Moulton was unanimously elected chairman, and at once commenced development with the same energy which had characterised his conduct of his department. But the circumstances were very

different. In place of the enthusiasm of the war the country seemed paralysed by the reaction which marked its close, and labour difficulties were present in every direction. Before any increase in the scale of production of dyes could take place, new plant must be provided, and the supply of this was held up for months by the moulders' strike. Every preparation that could be made for the future was pushed forward, and in particular the research programme was drawn up, but the progress made was of course far less than would have been the case in more normal times. But in spite of these difficulties, a very considerable augmentation of production had taken place before the end of his period of leave forced Lord Moulton, for the first time in his life, to leave a task unfinished.

But, though Lord Moulton had had to vacate command of the actual operations of our dye manufacture, he sought in other ways to assist the growth of those chemical industries which he regarded as so vital to this country and her people. His views as to our duty towards these were clearly expressed in an address to the British Chemical Manufacturers in February 1921, an address that merits study not only because of the vital importance of the subject treated, but also because, alas, it was the last of his public speeches.

He began by referring to what the war had shown :

“ You must remember that during the whole four

years of the war I had to endure practically the terror of what those [chemical] industries enabled our enemies to do. I was always urging the Treasury to allow me to buy ahead nitrate of soda from Chile. Our enemies were making it in unlimited quantities at home, and I am afraid to think what would have been the result if Germany had concentrated its submarine attacks on that narrow line going through the Panama Canal, and through which we got our supplies of nitrate. They had no anxieties on that score; we were never free of them."

Lord Moulton then turned to the political side of the question.

"Now, I am an old Free Trader, and I look back without any feeling but that of delight on much I have said in former years. But my definition of a Free Trader to-day would be a little more elaborate than that which used to satisfy me. I used to say with confidence, and with some accuracy, that the most rapid way to obtain national wealth, and to enjoy it, was to buy in the cheapest market. The last few years shows that this definition ought to be a little enlarged, and to-day it stands like this: 'That if your main object is the rapid acquisition of wealth and its enjoyment, and you are sure of continuous peace, then the best way is to buy in the cheapest market.' It does not sound a very great change, but the last four years have shown us that we could not calculate on continuous peace, still less can we calculate on it in the future. And it has taught us one great thing: that our main object should not be

solely the most rapid acquisition of wealth and its enjoyment, but that it should include the most perfect development of our greatest asset, for the greatest asset of a country is its own people.' There had always been an exception made to the doctrine of Free Trade even by the strictest Free Traders—that of war goods. But they forget that there are things which are just as really essentials, though they are only used for the purposes of peace, as are any of the munitions necessary for war. We no more dare leave our great industries at the mercy of a foreign country, than we dare trust to a foreign country for our guns or our ammunition. . . . It is not essential to prop up for ever an industry that does not make itself industrially remunerative, but when you look back upon the consequences of national neglect during a whole series of years, and find yourself obliged at the beginning of a war to call on industries to take up new branches, to expend their capital on them, to develop research, and to turn out in a few months that which must rival the result of years of work abroad, if you call upon them to come to your aid at a moment of danger like that, you must not think your duty to them has come to an end when the crisis is over. You first of all have to realise what they have done for you. But most of all you have to feel that you must take care that the danger does not recur. . . . I often feel that the political element in us finds formulæ so convenient that it loves to stick to them on all occasions, and ultimately christens them principles. It would be just about as sensible for a man not to take into consideration the exceptional conditions under which we are at the present time,

and to adapt his policy to the needs of those conditions, as it would be for a doctor who was a stern believer that there was no food so nutritious as beef-steak to administer it to a man with typhoid fever. You know what the result would be. . . . And if anybody, abandoning all questions of his past speeches, reflects on the consequence of allowing these essentially infant industries to meet the ruthless competition of the foreigners unaided, he must see that the consequences of his acts must be the destruction of these industries. The refusal of aid to them would be an example of how we forget this inexorable rule of the necessity of taking the consequences of our acts."

But he warned his audience that such help as they could claim or hope for would be temporary, not permanent—to foster growth, not to excuse sloth.

"I have a faith in both the theoretical and the industrial British chemist which has no limit. I decline to regard those of any other nation as superior to him in quality, though they may be vastly superior in experience and power of immediate production. And, therefore, I think you ought all to realise that the task you have ultimately to perform is to be able to stand without assistance in the markets of the world. . . . You must, if you are to succeed, take advantage of the breathing space thus allowed you, and develop, as I know you can, both by research and by industrial organisation, your power of production until you need no help and fear no enemy."

He concluded with these words :

“ The future of every nation with a dense population like England, with its great intellectual and industrial position, must depend on the extent to which it has realised the claims of chemistry and the needs of developing it industrially, and therefore it is that I say that in this question which is now being fought out, and which I am making the theme of my address, your success will be the salvation of England.”

This utterance of one who had worked so long and strenuously for his country and for science might well be accepted by men of all opinions as at least showing the gravity of the problem before us, whatever be the solution of this problem which seems best to them. If any weight is to be attributed to his words, it may at least claim to be treated as a question of utmost import, not to be dismissed with quips and jokes about the taxes on dolls' eyes, or criticisms of the minutiae which inevitably fringe the borderline of any law, but rather to be considered in the spirit proper to a decision which may well determine our final place among the nations.

During 1919 Lord Moulton was several times called on to assist our delegates at the Peace Conference in relation to dyes and chemical manufactures.

After the Armistice the first need of Germany was food-stuffs, and as she had not the cash to pay for them, a system of barter must be arranged. This presented difficulties, both from the point of view of finding goods available for export and of overcoming the prejudices of citizens of the allied countries to

such goods. In the case of dyes, however, neither difficulty existed—the Germans had large stocks and manufacturers had such need of them that they would be readily absorbed.

Various conferences were held between the Allied and German representatives on this point, but without any definite result. In March 1919 a meeting at Mayence had led to a recommendation that the Allies should requisition such dyes as they required from the stocks in the occupied territories, since it seemed clear that the dye-stuffs could not be obtained from Germany on reasonable terms, either by purchase or barter. But a few days afterwards another course—prohibition of exportation—was advocated, and a very confused situation had developed when in April 1919 Lord Moulton was called in to advise the British Delegates and the Supreme Economic Council.

The problem was a twofold one—firstly to obtain by rapid means the dye-stuffs which were needed by allied manufacturers—and especially France, Belgium, and Italy—at the moment, and secondly to arrange for a more permanent supply as part of the reparation scheme, and to enable Germany to obtain food-stuffs. His memorandum recommended requisition of supplies in the occupied territory, and this course was in fact adopted. The second and more permanent problem was also dealt with in accordance with his recommendation, which is practically embodied in Article 236 of the Peace Treaty, and gives the Allies the right to require delivery of 50 per cent. of any

dye-stuffs in existence in Germany at the date of the Treaty, and 25 per cent. of the amounts produced during the next five years, the value of the amounts being credited to Germany in reduction of the total due for reparation.

It is an open secret that Lord Moulton urged the Allies to avail themselves of a class of German assets which the Treaty left practically untouched. He of course knew that no considerable proportion of the amount due for reparation could be paid in gold, and he foresaw the difficulty of taking much either in raw or manufactured products, since this would produce unemployment in the corresponding trades in the countries receiving these products. But Germany had an invaluable asset in her technical secrets, and, if this asset could be reached, it would benefit the allied countries and produce employment in place of unemployment. He constantly urged that it should be made a term of the Treaty of Peace that such technical processes, with full working details, should be disclosed as the Allies might demand, and that this disclosure should be accompanied by proper opportunities for the inspection of the German factories. Of course this would have involved some hardship on individual German firms, which might well have been met by compensation from their own Government, but Lord Moulton took a decided view as to the obligation of Germany to pay for the misery and damage which she had caused, and to pay for it in the way which would be most beneficial to those

whom she had wronged. Unfortunately his view failed to prevail—largely owing to the opposition of the American delegates—and the Allies lost an asset which would have been of lasting value, though a somewhat emasculated clause, requiring Germany to disclose information as to those processes which had actually been used for producing munitions such as explosives or poison gases, was included in the Treaty.

Many other duties fell on Lord Moulton in the period after the war, amongst which were an inquiry into the affairs of the British Cellulose Company, a reference of claims against the Government in respect of certain wireless patents, and one of the inquiries as to the true inventors of the "Tanks." In 1920 he was elected as President of the Institute of Gas Engineers.

At Christmas 1920 Lord Moulton underwent a nasal operation for the purpose of facilitating his breathing. This was quite successful, but he took some little time to recover from its effects. He, however, resumed his duties in the House of Lords at the beginning of the Hilary Sittings, and heard several cases, including a very long appeal by a litigant in person who was claiming damages for alleged improper certification as a lunatic.

On Tuesday, March 8th, he sat in the Lords as usual, and spent the evening with his daughter-in-law. He seemed to have quite recovered his health, and was in the best of spirits when he went to bed. The next morning he was found dead by his valet.

From the absolutely peaceful expression of his face it was clear that death had been instantaneous and that he had suffered no pain whatever. The post-mortem showed that in fact death was due to a small clot in the artery feeding the heart muscle.

And so this great life, of which not a moment had been wasted, ended with a perfect death.

Great as were his contributions to the service of his country and mankind, I think that those who have really studied Lord Moulton's work will feel in some degree a sense of disappointment—of regret that his talents should have been confined by the limitations of one mortal life. There are many that regret that he did not devote his life to chemical or mechanical science, to others who read his medical contributions there must come a desire that his seventy years of study had been given whole-heartedly to the struggle against disease and suffering, while his crowning work during the war suggests that his real sphere was that of an administrator whose powers for good are multiplied and rendered effective by the multitudes he controls.

These regrets are vain. A mortal is granted but one life; but what he has done in that life may endure and bear fruit throughout countless generations. It is with a prayer that this may be my father's reward that I close this account of his life.

PRINTED IN GREAT BRITAIN
BY HAZELL, WATSON AND VINEY, LD.,
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